The US Army's Center for Strategy and Force Evaluation

STUDY REPORT
CAA-SR-96-6

PLANNING ENVIRONMENTAL RESOURCE STRATEGY EVOLUTION AND UTILIZATION STUDY (PERSEUS)

JULY 1996

PREPARED BY
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13. ABSTRACT (Maximum 200 words)

The purpose of PERSEUS was to develop and evaluate investment strategies to assist decision makers in prioritizing pollution abatement and prevention projects for US Army facilities and activities. The study applied the Pollution Abatement and Prevention Analysis (PAPA) methodology and a limited set of data to demonstrate three cases of development and evaluation of pollution prevention (P2) investment strategies. Case 1 developed a P2 investment strategy using only pollution prevention opportunities (PPO). Case 2 developed an integrated P2 investment strategy, combining both PPO and energy conservation opportunity (ECO) data. Case 3 related P2 investment strategy results to installation readiness, using C-ratings to characterize the contribution of the strategy toward achievement of Army environmental goals. Additional cases were planned using a more complete data set suitable to decision support but were deferred to such time when the data becomes available.

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REPLY TO
ATTENTION OF:

CSCA-RA (5-5d)

08 OCT 1996

MEMORANDUM FOR Deputy Chief of Staff for Installation Management,
ATTN: DAIM-ED, Washington, DC 20310-0600

SUBJECT: Planning Environmental Resource Strategy Evolution and Utilization Study (PERSEUS)

1. Reference memorandum, DAIM-ED-P2, 2 December 1994, subject: Planning Environmental Resource Strategy Evolution and Utilization Study (PERSEUS) Study Directive.

2. Reference memorandum requested the US Army Concepts Analysis Agency (CAA) to develop and evaluate investment strategies to assist decision makers in prioritizing pollution abatement and prevention projects for US Army facilities and activities.

3. The enclosed report documents the results of our analysis. The study summary at the beginning of the report provides an overview of the study.

4. Questions and/or inquiries should be directed to the Resource Analysis Division, U.S. Army Concepts Analysis Agency, 8120 Woodmont Avenue, Bethesda, MD 20814-2797, DSN 295-5289.

E. B. VANDIVER III
Director

Encl

	PLANNING ENVIRONMENTAL RESOURCE STRATEGY AND UTILIZATION STUDY (PERSEUS)	STUDY SUMMARY CAA-SR-96-6

THE REASON FOR PERFORMING THE STUDY was to develop and evaluate investment strategies to assist decision makers in prioritizing pollution abatement and prevention projects for US Army facilities and activities.

THE STUDY SPONSOR was the US Army Assistant Chief of Staff for Installation Management (ACSIM).

THE STUDY OBJECTIVES were to:

(1) Develop a pollution prevention opportunity data base for Army installations in the US.

(2) Apply the Pollution Abatement and Prevention Analysis (PAPA) methodology to generate and analyze:

(a) Pollution prevention investment strategies in response to Executive Order 12856, Pollution Prevention and Right-to-Know, which directs a 50 percent reduction (from 1994 baseline) of toxic chemical releases by Federal agencies by 1999.

(b) Integrated pollution prevention/energy conservation investment strategies in response to the Secretary of Defense (SECDEF) memorandum, dated 11 August 1993, which directed the military services to submit detailed milestone plans to "improve the Department of Defense environmental performance."

(3) Relate investment strategy results to measures of installation readiness reflecting contribution towards environmental goals.

THE SCOPE OF THE STUDY

(1) Consider Army installations in the US, to include the US Army Materiel Command, the US Army Forces Command, and the US Army Training and Doctrine Command.

(2) Conduct study in two phases. Phase I will use an Initial Data Base developed from the most immediately accessible pollution prevention opportunity and energy conservation opportunity data. Phase II will use a Revised Data Base reflecting adjustments and additions to the Initial Data Base.

(3) Identify pollution prevention opportunities and energy conservation opportunities in investment strategies by type, number, installation, and fiscal year (FY) of acquisition.

(4) Consider off-the-shelf pollution prevention opportunity/energy conservation opportunity technologies.

(5) Analyze the period of FY 1994-2005, and include other FY periods of interest, as appropriate.

THE BASIC APPROACH of the study was to apply the PAPA methodology, developed earlier by the US Army Concepts Analysis Agency, to support environmental decision making by senior Army leadership. The methodology provides an analytical framework (using multiple objective mathematical programming) for developing and evaluating the costs and benefits of investing in pollution prevention opportunity at Army activities and facilities.

THE PRINCIPAL FINDINGS of the PERSEUS Study are:

(1) When dollars are discounted, the pollution prevention investment strategy, in particular the timing of the pollution prevention investments, significantly affects the life cycle cost savings/avoidance of the investments.

(2) Energy conservation opportunities, when integrated into the pollution prevention investment strategy, provide cost savings/avoidance benefits comparable to those of pollution prevention opportunity. However, the investment in these energy conservation opportunities, while providing reduction in key air emissions, does not provide reduction or prevention of releases that contribute to the 50 percent reduction in toxic releases required by Executive Order 12856.

(3) The results of the investment in pollution prevention opportunity over an investment period can be portrayed as a trend of pollution reduction over time which can be readily translated into installation readiness measures. These measures are suitable for use by decision makers when comparing different pollution prevention investment strategies, as well as for assessment of the environmental conditions at individual installations, major Army commands (MACOM) and Armywide.

(4) The data for Phase II defining the project benefits was anticipated to be available from installation pollution prevention plans to be completed by the end of 1995. However, when this data was reviewed, it was not sufficiently complete to support Army pollution prevention strategy development. As a consequence, and with the concurrence of the sponsor, work on the study was concluded with Phase I. Reporting requirements, however, have been established for the submission of environmental program requirements to include the project benefits required for use with the PAPA methodology. With the availability of such data, analysis of pollution prevention investment strategies using the PAPA methodology should be conducted.

THE STUDY EFFORT was directed by Mr. James J. Connelly, Resource Analysis Division, US Army Concepts Analysis Agency (CAA).

COMMENTS AND SUGGESTIONS may be sent to the Director, US Army Concepts Analysis Agency, ATTN: CSCA-RA, 8120 Woodmont Avenue, Bethesda, MD 20814-2797.

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PLANNING ENVIRONMENTAL RESOURCE STRATEGY EVOLUTION AND UTILIZATION STUDY (PERSEUS)

CHAPTER 1

EXECUTIVE SUMMARY

1-1. PURPOSE. To develop and evaluate investment strategies to assist decision makers in prioritizing pollution abatement and prevention projects for US Army facilities and activities.

1-2. BACKGROUND

a. The Pollution Prevention Act of 1990 declared it national policy that pollution be prevented or reduced at the source, or the pollutants otherwise recycled in a safe manner. The Act further directed the filing of annual toxic chemical source reduction and recycling reports. In furtherance of this policy, Executive Order (EO) 12856, Pollution Prevention and Right-to-Know, directed a 50 percent reduction (from 1994 baseline) of toxic chemical releases by Federal agencies by 1999, as well as the preparation of plans by the end of 1995 to achieve these reductions.

b. The Energy Policy Act of 1992 declared it national policy that all energy efficient and renewable energy measures that pay back in 10 years or less be implemented by 2005. In furtherance of this policy, EO 12902, Energy Efficiency and Water Conservation, directs development and implementation of a program for increase in energy efficiency by Federal agencies by 30 percent (from 1985 baseline) by 2005, as measured per gross square foot of the agency's buildings in use.

c. The Secretary of Defense (SECDEF), in a memorandum dated 11 August 1993, directed the military services to submit detailed milestone plans to "improve the Department of Defense environmental performance by actively implementing policies that embrace pollution prevention in all phases of the acquisition process, the procurement of goods and services and in life-cycle management at our installations."

d. In responding to this guidance, the Army requires a quick turnaround decision support capability, as provided by the Pollution Abatement and Prevention Analysis (PAPA) methodology, to systematically develop and evaluate the most effective pollution prevention investment strategies.

e. As a part of the development of the PAPA methodology (Ref 1), an effort was made to assemble benefits data in the form of cost/avoidance savings and pollution reduction associated with pollution prevention and abatement projects. This data was not available in the data base supporting the Army environmental program requirements, and efforts to collect the data from existing technical documentation was limited to the identification of 26 pollution prevention opportunities with cost savings/avoidance and pollution reduction data. With this lack of data in mind, the study was scoped (see paragraph 1-3) to deal with the existing data limitations, and expectations that data would become available from the installation pollution prevention plans to be prepared, by mandate of EO 12856, by the end of 1995.

1-3. SCOPE

a. The study will be conducted in two phases. Phase I will use the PAPA methodology with an Initial Data Base developed from the most immediately accessible pollution prevention opportunity and energy conservation opportunity data. Phase II will use the PAPA methodology with a Revised Data Base reflecting adjustments and additions to the Initial Data Base, using information provided in the installation pollution prevention plans

b. The pollution prevention investment strategies will identify pollution prevention opportunities and energy conservation opportunities by type, number, installation, and FY of acquisition.

c. The strategies will consider off-the-shelf pollution prevention opportunities/energy conservation opportunities.

d. The strategies will address the overall time period of FY 1994-2005 and include other FY periods of interest, as appropriate.

e. The study will consider Army installations in the US, to include the US Army Materiel Command, the US Army Forces Command, and the US Army Training and Doctrine Command.

1-4. OBJECTIVES

a. Develop pollution prevention opportunities data base for Army installations considered.

b. Apply the PAPA Investment Model to generate and analyze:

(1) Pollution prevention investment strategies in response to EO 12856, Pollution Prevention and Right-to-Know, which directs a 50 percent reduction (from 1994 baseline) of toxic chemical releases by Federal agencies by 1999.

(2) Integrated pollution prevention/energy conservation investment strategies in response to the SECDEF memorandum, dated 11 August 1993, which directed the military services to submit detailed milestone plans to "improve the Department of Defense environmental performance."

c. Relate investment strategy results to measures of installation readiness reflecting contribution toward environmental goals.

1-5. METHODOLOGY. The core of the study methodology is the use of the PAPA methodology for the development and evaluation of pollution prevention investment strategies. The key elements comprising the development and evaluation of the investment strategy are illustrated in Figure 1-1. The investment strategies developed are selected to respond to the individual objectives of the study (paragraph 1-4). To meet these objectives, the key elements of the development and evaluation (inputs and outputs), as shown in Figure 1-1, are organized into packages of analysis, identified as case studies, each of which responds to a particular study objective. Each case study is conducted with its own set of inputs characterizing the investment conditions and produces a set of outputs characterizing the costs and benefits of the pollution prevention investment. The organization of the study into case studies is summarized in Tables 2-1 and 2-2 in Chapter 2. The details of each case study are described in Chapter 3.

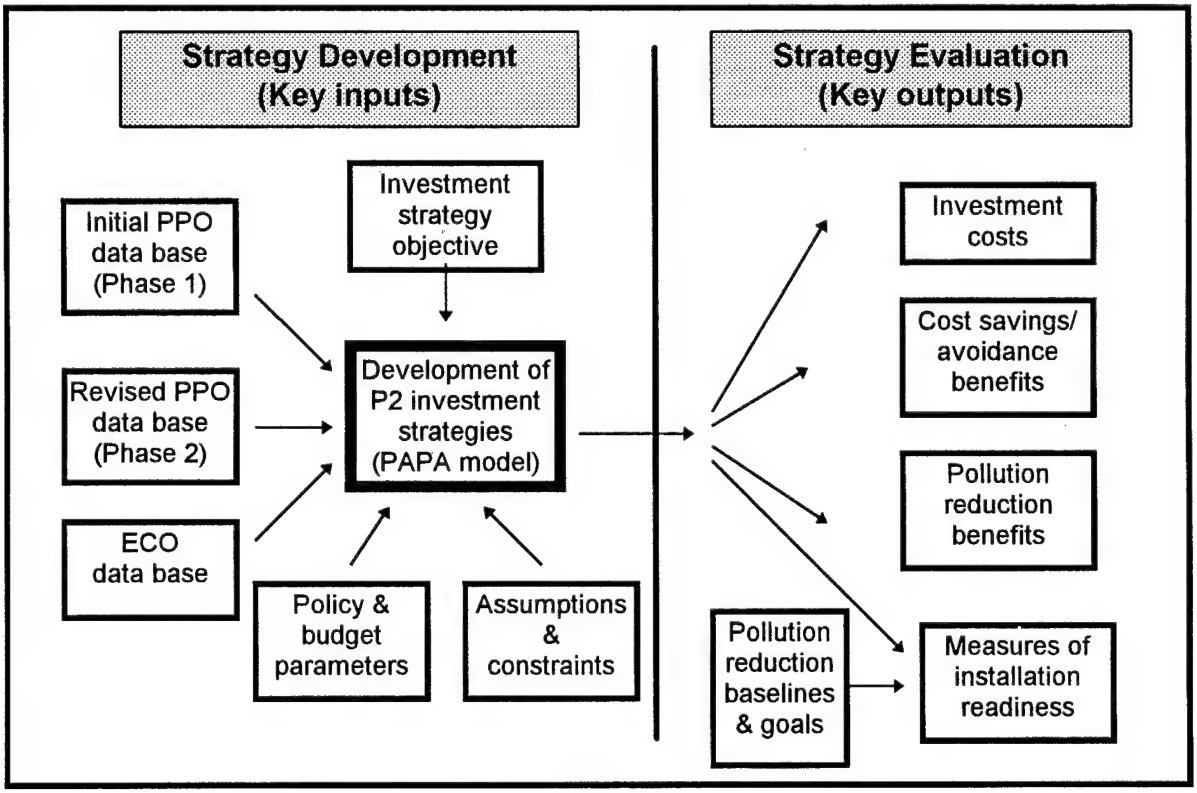

Figure 1-1. Methodology for Development and Evaluation of Pollution Prevention Investment Strategies

1-6. FINDINGS AND RECOMMENDATIONS. The following are the findings and recommendations of the PERSEUS Study as they respond to the objectives to the study.

a. Prioritization Pollution Prevention Investment Strategy. The study has demonstrated that when dollars are discounted to reflect the time value of money, the pollution prevention investment strategy, in particular the timing of the pollution prevention investments, significantly affects the life cycle cost savings/avoidance of the investments. A maximize cost savings/ avoidance investment strategy, as compared with a minimize cost savings/avoidance strategy which spends the same amount of money, clearly illustrates the preferred outcome of the strategy prioritized for higher cost savings/avoidance. The comparison implies that any other timing of pollution prevention investments, spending the same amount of money, will lie between the bounds of these two limiting cost savings/avoidance strategies.

Recommendation. The PAPA methodology should be used as a management tool by environmental decision makers to prioritize and evaluate pollution prevention investment strategies to prevent or reduce pollution in support the requirements of EO 12856.

b. Integrated Pollution Prevention Investment Strategy. Using detailed energy conservation opportunity characteristics (to include both energy efficient and renewable energy technologies) developed by the US Army Construction Engineering Research Laboratory for an earlier effort (Ref 2), the study has demonstrated that the energy conservation opportunities, when integrated into the pollution prevention investment strategy, provide cost savings/avoidance benefits comparable to those of the pollution prevention opportunities. However, the investment in these energy conservation opportunities, while providing reduction in key air emissions, does not involve the reduction or prevention of toxic releases that contribute to the 50 percent reduction in toxic releases required by EO 12856.

Recommendation. The PAPA methodology should be used as a management tool by environmental decision makers to prioritize and evaluate pollution prevention investment strategies to integrate energy conservation opportunities and pollution prevention opportunities in response to the SECDEF memorandum of 11 August 1993.

c. Pollution Prevention Investment Strategy Environmental Measures. The study has demonstrated that the results of the investment in pollution prevention opportunities over an investment period can be portrayed as a curve of pollution reduction over time. In addition to portrayal in graph form, the pollution reduction results can be interpreted in a manner consistent with the installation readiness measurement methodology used in the Headquarters, Installation Status Report (ISR), namely the use of C-ratings (i.e., C-1 for highest readiness to C-4 for lowest readiness). The extent of the reduction provided by an investment strategy can be expressed as falling within a range, corresponding to a C-rating measure. This C-rating measure may be used by decision makers when comparing different pollution prevention investment strategies, and their impact on the environmental conditions on individual installations, on MACOMs and Armywide.

Recommendation. The pollution reduction over time, arising from the pollution prevention investment strategies generated by the PAPA methodology, should be used to generate C-rating measures of installation readiness for use in the assessment of the strategies.

d. Pollution Prevention Opportunities Data Base Development

(1) Phase 1 Data Base. The development of the Phase I - Initial Data Base involved generation of a list of 143 pollution prevention opportunities, using inputs informally provided by MACOM environmental managers. The benefits data for these pollution prevention opportunities was limited to cost savings/avoidance values, but not pollution reduction values. This data was used as part of Case Studies 1, 2, and 3 (see Table 2-1). The study results for Phase I are documented in this report.

(2) Phase II Data Base. The development of the Phase II - Revised Data Base was terminated when the project benefits data anticipated to be available from the installation pollution prevention plans by the end of 1995 were not sufficiently complete to support Army pollution prevention investment strategy development, as envisioned in Case Studies 4, 5, and 6 (see Table 2-2). As a consequence, and with the concurrence of the sponsor, work on the study was concluded with Phase I. However, based on unavailability of pollution prevention project benefits data experienced in the study, reporting requirements have been established for subsequent submissions of environmental program requirements, to include the cost savings/avoidance and pollution reduction benefits of the projects required for the PAPA methodology.

Recommendation. Contingent upon development of a complete and validated pollution prevention opportunities data base with cost savings/avoidance and pollution reduction benefits data, analysis of pollution prevention investment strategies using the PAPA methodology should be conducted.

CHAPTER 2

METHODOLOGY

2-1. INTRODUCTION. This chapter describes the methodology used to achieve the objectives of the PERSEUS Study. The core of the study methodology is the use of the PAPA methodology for the development and evaluation of pollution prevention (P2) investment strategies. An investment strategy is a particular program of acquisition which specifies the number and type of each pollution prevention opportunity (PPO) and/or energy conservation opportunity (ECO) to be acquired for each Army installation in each fiscal year of the acquisition program. The investment strategies developed are selected to respond to the individual objectives of the PERSEUS Study namely: (1) EO 12856--directing a 50 percent reduction (1994 baseline) of toxic chemical releases by Federal agencies by 1999, (2) SECDEF memo of 11 August 1993--directing the military services to develop plans to integrate pollution prevention opportunities and energy conservation opportunities, and (3) relating the investment strategy results to measures of installation readiness reflecting contribution toward environmental goals.

2-2. METHODOLOGY OVERVIEW. The key elements (inputs and outputs) comprising the development and evaluation stages of the P2 investment strategy are illustrated in Figure 2-1. To meet the objectives of the study, the key elements are organized into case studies. Each analysis is conducted with its own set of inputs characterizing the investment conditions and produces a set of outputs characterizing the scope and impact of the P2 investment. The focus of each study is the development of one or more P2 investment strategies using the PAPA Model. The PAPA methodology provides a formal analytical framework (using multiple objective mathematical programming) for development of prioritized P2 investment strategies which identify an overall program of investment by type, number, and installation, for each year in the acquisition period of interest. Through selection of the range of input and output data, the analyses may be focused at the Army, MACOM, or installation level. The following paragraphs describe the nature of the key elements and the organization of the study into a series of case studies. The details of each case study are included as part of the analysis and results presented in Chapter 3.

2-3. STRATEGY DEVELOPMENT. The strategy development stage, as shown in Figure 2-1, involves the elements described in the following paragraphs.

a. Investment Strategy Objective. The PAPA mathematical programming methodology can implement a variety of P2 investment strategy objectives including maximization of cost savings/avoidance (see paragraph 2-4b) and pollution reduction, both of which are used in the present analysis.

b. Policy and Budget Parameters. The policy and budget parameters for a particular investment strategy define the annual amount of funding, the funding timeframe, and the funding objective to be achieved (e.g., maximize cost savings/avoidance (CS/A) (see paragraph 2-4b) or maximize pollution reduction (PR)). All funding is manipulated in constant dollars and the results expressed in constant, current, or discounted dollars, as desired.

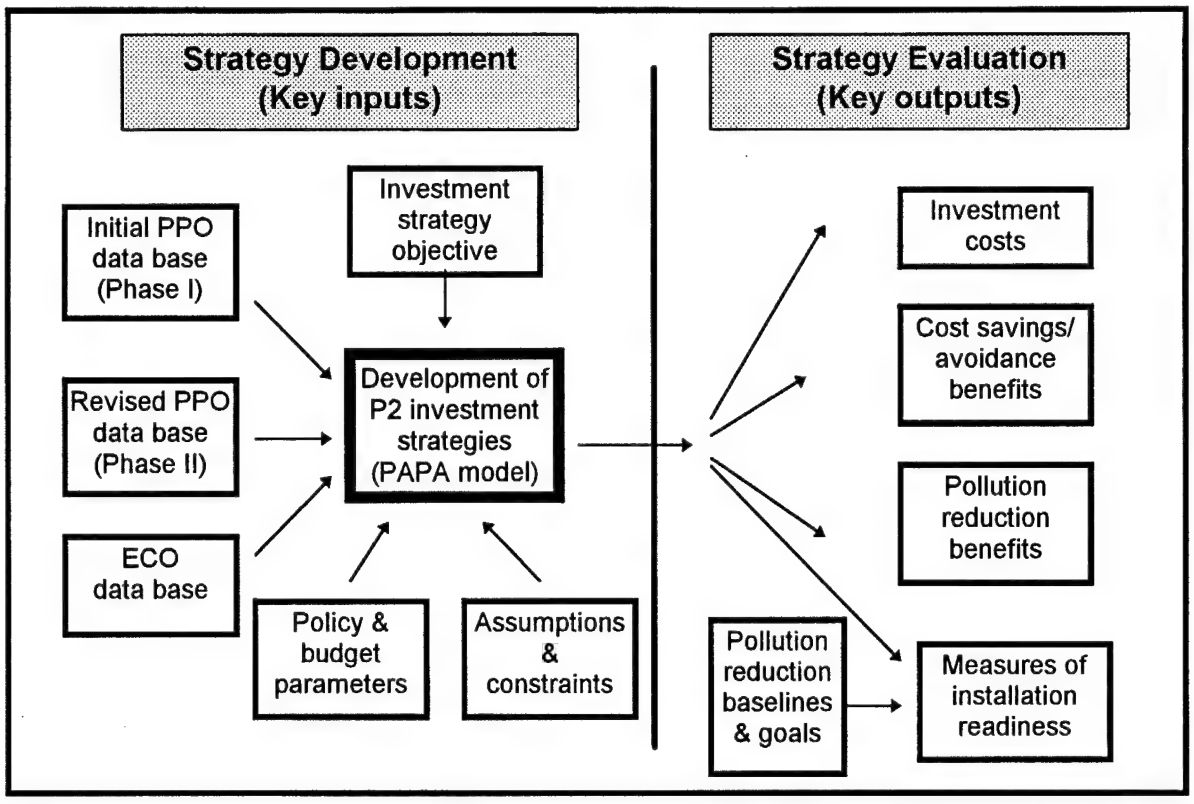

Figure 2-1. Methodology for Development and Evaluation of Pollution Prevention Investment Strategies

c. Assumptions and Constraints. Associated with the implementation of the investment strategy are assumptions and constraints on the manner in which the methodology handles investment costs, benefits, and evaluation of the strategy. For the investment strategies described in this study the following apply:

- Costs and benefits are assigned in the year in which the opportunity is funded. There is no delay to a subsequent year to allow the project to be brought on line.

- Benefits continue over the funding period. The project is assumed to be useful over the entire period of acquisition and its performance does not degrade or otherwise fail.

d. PPO Data Base. The preparatory work for the study determined that the PPO data required by the PAPA methodology was not complete, and that the data development would proceed in two phases. In Phase I, the PPO data currently available is used to the extent possible to demonstrate the strategy development and evaluation capability of the methodology. In Phase II, PPO data assembled and validated for environmental program support is used. The data available in Phase I is limited to PPO costs and PPO benefits in the form of PPO CS/A, but not

PPO pollution reduction. The strategy development in Phase I, therefore, cannot address objectives involving the pollution reduction benefit. However, a limited set of PPO pollution reduction data is available from an earlier (Ref 1) study. This earlier, limited data set is used in place of the Initial Data Base to illustrate the study analysis objective to relate investment strategy results to measures of installation readiness. The strategy development in Phase II is conducted using a full complement of PPO cost and benefit data.

e. ECO Data Base. For both Phase I and 2, ECO data developed by the US Army Construction Engineering Research Laboratory, and used in the Synthesizing Energy Worth Study (Ref 2), would be used.

f. Development of P2 Investment Strategies. The PAPA Model accepts the investment strategy objective, policy and budget parameters, and PPO/ECO data as input. The model is then run to generate the investment strategy. The strategy developed is in the form of a list of the PPO/ECO to be acquired, by number and year of the funding period, for each installation.

2-4. STRATEGY EVALUATION. The strategy evaluation stage, as shown in Figure 2-1, involves postprocessing of the run results to evaluate the costs and the benefits associated with the strategy. The results are presented in the form of charts and tabular summaries, as described in the following paragraphs.

a. Investment Costs. The cost of the investment is a display of the total amounts funded in each year of the funding period. The amount by year is identical to the amount prescribed under the investment conditions but is also computed, as desired, by MACOM and installation. The investment costs are also calculated and displayed over the life cycles of the PPO/ECO.

b. Cost Savings/Avoidance Benefits. The CS/A associated with the investment strategy is computed using the CS/A values for each of the individual PPO, as provided in the input data. The CS/A for each strategy is computed for two intervals: (1) the duration of the funding period for the investment (typically 6 years), and (2) over the economic (useful) lives of the PPO acquired. Based upon discussions with resource managers at Headquarters, Department of the Army (HQDA), MACOM, and installation levels, use of the compound term *cost savings/ avoidance* has been adopted to recognize that the issue of whether a project actually reduces costs (cost savings) or avoids anticipated costs (cost avoidance) is problematical, and its resolution is outside the scope of this study.

c. Pollution Reduction Benefits. The pollution reduction benefits associated with the investment (measured in pounds of pollutant no longer being generated) is computed over the period from the year in which the PPO is acquired by the strategy, to the last year of its useful (economic) life. The pollution reduction for each strategy is computed for both the funding period for the investment (typically 6 years), and over the economic (useful) lives of all the PPO acquired. Of particular interest in responding to the pollution reduction mandate in EO 12856 is the pollution reduction achieved by the investment strategy through FY 1999, the target date for achieving the 50 percent pollution reduction. Depending upon the needs of the decision maker, the pollution reduction against the mandate may be computed at the installation level, or using

aggregated pollution data computed for the MACOM level, and for the overall Army. In addition to the reduction in the weight of waste achieved, the expression of this reduction in terms of installation readiness is also considered, as discussed in the next paragraph.

d. Measures of Installation Readiness

(1) Pollution Reduction Measured by Pollutant Weight. To provide measures of installation readiness associated with the P2 investment strategy, the annual pollution measured in units of kilograms (kg) of waste, are compared to the pollution baseline year of 1994. Progress toward the goal of a 50 percent reduction in pollution weight is then assessed as the ratio (in percent) of the pollution weight to the goal reduction amount. For example, if an installation generated 500,000 kg of pollutants in 1994, the pollution reduction goal for 1999 is 50 percent of 500,000 or 250,000 kg. If the installation pollution weight, using the P2 investment strategy, is 300,000 kg by 1999, then the pollution reduction from 500,000kg to 300,000kg, or 200,000 kg when expressed as a percentage of the goal reduction amount, is the ratio of 200,000/250,000, or 80 percent.

(2) Pollution Reduction Measured by C-rating. The percentage of the pollution reduction goal achieved may also be expressed as a C-rating, comparable to the C-rating measures used in the HQDA Installation Status Report Decision Support System. In the ISR system, installation environmental readiness is assessed as being at one of four possible levels, from C-1, the highest level of readiness, to C-4, the lowest level of readiness. To assign C-ratings for pollution reduction toward the 50 reduction goal, the reduction in percent is compared with each of four percentage ranges corresponding to the C-1 to C-4 ratings. Such C-rating ranges for pollution reduction achievement against a goal are not presently implemented, but for purposes of illustration, assume the ranges are as follows: C4 (lowest achievement) range: 0-25 percent, C-3 range: 25-50 percent, C-2 range: 50 -75 percent, and C-1 (highest) range: 75-100 percent. For the 80 percent reduction described in the previous paragraph, the C-rating for the installation readiness falls in the 75-100 percent range, and is rated as C-1. Such C-rating measures of installation readiness, as associated with each P2 investment strategy, are available, along with other cost and benefit information, for use in the assessment of the P2 investment strategies.

2-5. ORGANIZATION OF ANALYSIS. The organization of the work is based on a case study approach, where a separate case study is used to address each of the three objectives of the study. Case studies are established for each study phase.

a. Phase I. For the Phase I PPO Initial Data Base, where the data are incomplete, the three cases are run at the Armywide level, and the environmental measures for the pollution reduction objective are met using pollution reduction data from an earlier study which was limited to PPO at eight Army industrial operations.

b. Phase II. For the Phase II Revised PPO Data Base, where complete data (including pollution reduction data) is present, the three cases are again run at the Armywide level (using PPO for all MACOM), and in the case where the P2 investment strategy (IS) is generated, rerun for each individual MACOM (using PPO appropriate to MACOM). A summary of the six cases for Phases I and II are shown in Tables 2-1 and 2-2, respectively.

Table 2-1. Phase I Case Studies

Case study	Case level	Analysis objective	Analysis procedure
-- Case 1 -- P2 Investment Strategy Comparison	Armywide	Generate and evaluate P2 investment strategies in response to pollution reduction mandate of EO 12856	1. Generate an Armywide IS for PPO, with a maximize CS/A objective and then repeat with a minimize CS/A objective 2. Compare the IS costs and CS/A of the strategies on a discounted basis
-- Case 2 -- Integrated P2 Investment Strategy	Armywide	Combine P2 and energy conservation opportunities in single integrated P2 investment strategy	1. Generate an Armywide IS combining PPO and ECO, with a maximize CS/A objective 2. Compare CS/A contributions of PPO and ECO
-- Case 3 -- P2 Investment Results as Installation Readiness Measures	Selected industrial base operations	Relate P2 investment strategy results to measures of installation environmental readiness	1. Generate an IS with a maximize PR objective 2. Interpret PR achieved as C-ratings, comparable to C-ratings used in the ISR

KEY:

IS-investment strategy
CS/A-cost savings/avoidance
PR-pollution reduction

Table 2-2. Phase II Case Studies

Case study	Case level	Analysis objective	Analysis procedure
-- Case 4 -- P2 Investment Strategy Evaluation and Comparison	Each MACOM and Armywide	Generate and evaluate P2 strategies in response to pollution reduction mandate of EO 12856	1. Generate IS for PPO with a maximize CS/A objective, and then repeat with a maximize PR objective 2. Evaluate impact of IS in terms of annual and aggregate benefits 3. Compare costs and benefits across MACOM, and MACOM component to Army
-- Case 5 -- P2 Integrated Investment Strategy	Armywide	Combine P2 and energy conservation opportunities in single integrated investment strategy	1. Generate IS combining PPO and ECO, with a maximize CS/A objective, and then repeat with a maximize PR objective 2. Evaluate impact of IS in terms of annual and aggregate benefits 3. Compare costs and benefits of PPO vs ECO
-- Case 6 -- P2 Investment Results as Installation Readiness Measures	Armywide	Relate investment results to measures of installation environmental readiness	1. Interpret PR results from Case 4 as C-ratings, comparable to C-ratings used in the ISR

KEY:

IS-investment strategy
CS/A-cost savings/avoidance
PR-pollution reduction

CHAPTER 3

ANALYSIS AND RESULTS

3-1. INTRODUCTION. This chapter describes the analysis conducted during the PERSEUS Study in accordance with the study methodology described in Chapter 2. In accordance with this methodology, the analysis was organized into two phases, reflecting the nature of the data available for the analysis, with three cases of analysis in each phase. The initial work in each phase was development of a data base with the support of the Army Environmental Center.

3-2. ORGANIZATION OF PHASE I ANALYSIS AND RESULTS. The organization of the analysis for Phase I work, as prescribed by the study methodology, consists of the following tasks:

- Development of Phase I Data Base
- Case Study 1--P2 Investment Strategy Comparison
- Case Study 2--Integrated P2 Investment Strategy
- Case Study 3--P2 Investment Installation Readiness Measures

For each of these cases, specific investment situations, focused on the issue presented by the case, are used as the basis for the analysis.

3-3. DEVELOPMENT OF PHASE 1 DATA BASE

a. Data Requirements. The data requirements associated with the use of the PAPA methodology have been previously identified (Ref 1) and consist of the following:

- Initial and Recurring Costs
- Annual Cost Savings/Avoidance
- Annual Pollution Reduction

b. Data Availability. As described earlier in the Scope paragraph (paragraph 1-3), it was anticipated that Phase I of the study would employ an initial data set, which would allow demonstration of the PAPA methodology. In the interim, efforts were to be made to assemble a more complete data set for use in Phase II of the study.

c. Data Source. The data set used in Phase I had its origin in the funding submission (dollar) estimates provided by the MACOMs, in response to a data call for pollution prevention funding estimates for FY 97-01 from the Office of the Director of Environmental Programs (ODEP) (Ref 3). Subsequent to receipt of the submissions by ODEP, MACOM environmental program managers who had provided the funding submissions to ODEP were contacted for data on the individual projects associated with the submissions. The MACOM manager response to the request for the individual projects was substantial, but not complete. The principal indicator of the incomplete data was an assessment showing that the sum of the individual project costs, as submitted after the funding estimates, was less than the funding estimates provided to ODEP in

the submissions. Adjustment of the data, to reconciliation and/or rationalize the differences, was needed before the project data could be used for demonstration purposes.

d. Data Adjustment. To use the data for demonstration purposes, the data for the individual projects was adjusted in three areas: (1) absence of annual CS/A data, (2) absence of annual pollution reduction data, and (3) the more general problem of the absence of project listings.

(1) Absence of Annual Cost Savings/Avoidance Data. Where CS/A data were not provided by the MACOM, values were assigned, either by assignment of values from comparable projects at other MACOM, or by estimating the values from projects which were similar in technology.

(2) Absence of Annual Pollution Reduction Data. There was a widespread absence of data on project pollution reduction for the individual projects submitted by the MACOM. A review of the P2 project documentation failed to provide a useful number of instances where pollution reduction values had been computed or estimated. Lacking any reasonable point of departure for estimating the pollution reduction benefits, it was determined to limit consideration of pollution reduction to Case Study 3 in the Phase I demonstration of the PAPA methodology.

(3) Absence of Project Listings. In those instances where the MACOM projects listings were incomplete, projects reported as environmental program requirements in the latest available (FY 94) Environmental Program Requirements report by the MACOMs were used to supplement the project listings. To the extent that the earlier reporting requirements included project cost data, but not project benefit data, the annual CS/A benefit data were assigned, as described above (paragraph 3-3d(1)).

e. Assessment of Data Adjustments. These data adjustments were conducted on a limited scale and were considered an effective representation of the PPO data for demonstration purposes. The informal data collection and data editing process also served to anticipate the collection conditions for the Phase II data collection effort. The Phase I data set, as prepared from the collection and adjustment efforts, is documented in Appendix D.

3-4. CASE STUDY 1--P2 INVESTMENT STRATEGY COMPARISON

a. Investment Issue. This case of environmental investment, comparing use of maximized vs minimized CS/A, was selected to demonstrate the widest possible range in CS/A benefit with the PPO in the data set. It contrasts the maximum CS/A benefit possible with the least benefit possible for the same set of PPO, for a given funding profile over the investment period. To heighten the effect of the contrast, the constant dollars used during the execution of optimization are converted to discounted dollars. The discounted dollars convert the benefits flows to economically comparable amounts at a common point in time by considering the time value of money. Both the maximize and minimize CS/A objectives generate pollution reduction benefits, but the amount and timing of these benefits are not evaluated due to lack of PPO pollution reduction data (paragraph 3-3d(2)).

b. Investment Strategy Development. The investment conditions for Case Study 1 are shown in the following exhibit.

Investment Strategy Conditions--Case Study 1

Objective:
- ♦ Maximize cost savings/avoidance
- ♦ Minimize cost savings/avoidance

Policy and budget parameters:
- ♦ Fund at level to acquire all opportunities
- ♦ Allocate investment based on MACOM pollution prevention submissions for funding period FY 96-01

Assumptions and Constraints:
- ♦ Assign costs and benefits in year funded
- ♦ Benefits continue over funding period
- ♦ Compare costs and benefits in discounted dollars (FY 95)

Data Set:
- ♦ No of PPO: 143

The investment strategies generated by PAPA for both the maximize and minimize CS/A objectives are listed (because of their detail) in Appendix E, Tables E-1 and E-2. An excerpt from both these tables for the US Army Corps of Engineers (USACE) is shown in Table 3-1. The excerpts have been edited to show the number of PPO just in the FY in which they are acquired, and not the repeated entry for the rest of the remainder of the planning period, as appears in the Appendix E tables. The edited excerpts are discussed in the next paragraph.

c. Investment Strategy Comparison. For the purposes of explanation, the PPO entries for the maximize and minimize objectives are combined in a split table. The entries for the maximize objective strategy are shown in the upper half of the table, and the entries for the minimize objective strategy table are shown in the lower half of the table. In accordance with the investment condition to "fund at a level to acquire all opportunities," all the PPO for the MACOM are acquired for both investment objectives. The PPO in Table 3-1 are numbered 117-119 as they appear in the investment strategy tables in Appendix E. As shown in Table 3-1, the sequence of acquisition of the PPO is seen to vary with the objective. When the objective of the strategy is to *maximize* CS/A, PPO 117 is acquired early in the investment period (FY 96), and PPO 118 and PPO 119 are acquired later in the period (FY 00). Conversely, when the objective of the strategy is reversed, to *minimize* CS/A, the same PPO reverse their locations in the funding period, with PPO 117 now acquired later in the period (FY 00), and PPO 118 and PPO 119 acquired earlier in the investment period.

Table 3-1. Comparison of Investment Strategies (Case Study 1)

PPO no.	MACOM	PPO name	Number of PPO acquired by FY FY 96	FY 97	FY 98	FY 99	FY 00	FY 01
Maximize cost savings/avoidance objective								
117	USACE	Automated chemical tracking system	1	0	0	0	0	0
118	USACE	Freon replacement	0	0	0	0	1	0
119	USACE	Halon system replacement	0	0	0	0	1	0
Minimize cost savings/avoidance objective								
117	USACE	Automated chemical tracking system	0	0	0	0	1	0
118	USACE	Freon replacement	1	0	0	0	0	0
119	USACE	Halon system replacement	1	0	0	0	0	0

d. Investment Strategy Evaluation. The evaluation of the investment strategy is conducted using three measures to characterize the investment and its results: (1) annual investment costs--as they occur over the investment period of FY 96-01, (2) cumulative CS/A--over the life cycle of the investment in the PPO, that is, until the last PPO acquired is retired from service, and (3) aggregate cost results--over the life cycle of the investment in PPO. The evaluation using these measures is described in the following paragraphs.

(1) Annual Investment Costs. The annual investment costs are based on the total of the MACOM pollution prevention submissions (in FY 95 dollars) to ODEP over the investment period FY 96-01. The MACOM submissions vary by FY, based on the MACOM submissions for each FY, as shown by the constant FY 95 dollar graph in Figure 3-1. Accompanying constant FY 95 dollar graph is the corresponding graph for the submissions, converted to FY 95 discounted dollars.

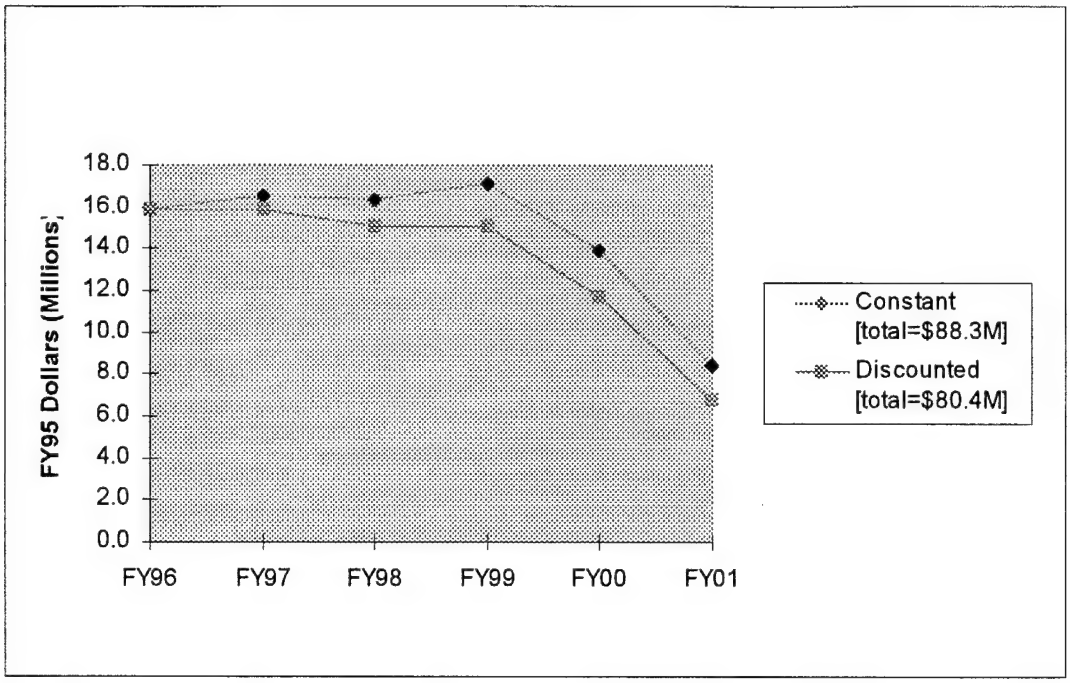

Figure 3-1. Annual Investment Costs (Case Study 1)

The discounted dollars graph converts the annual investment cash flow to a common point in time (i.e., FY 95) to take into account the time value of the invested money. This conversion to FY 95 discounted dollars is made using the discount rates prescribed by the Department of the Army, Office of the Assistant Secretary (Financial Management and Comptroller) (Ref 4), and reflects the government's cost of capital. The legend in the figure includes the investment totals over the funding period expressed in both constant and discounted dollars.

(2) Cumulative Cost Savings/Avoidance. The cumulative CS/A associated with the maximize objective and minimize CS/A objectives, over the life cycle of the PPO, and expressed in FY95 discounted dollars, is shown in Figure 3-2. The area between the graphs illustrates the difference in the cumulative CS/A between the maximize and minimize objectives. For the maximize objective, the cumulative CS/A is seen to rise quickly in the initial period to a maximum value due to early investment in the more economically efficient PPO, while for the minimize objective, the cumulative CS/A is seen to rise more slowly due to early investment in the less economically efficient PPO. By the end of funding period (FY 01), all the PPO are acquired under both strategies. From this point on, the cumulative CS/A for both objectives are driven only by the existing PPO as they work through their individual life cycles and drop out over time, as indicated by the tapering-off trend of the graphs. Since the more economically efficient PPO, including those with longer economic lives, are acquired earlier in the maximize objective case, these PPO phase out earlier and draw down the cumulative CS/A faster in the maximize objective graph. For the minimize objective case, these more economically efficient PPO are bought later in the funding period and therefore have life cycles which extend further into the future.

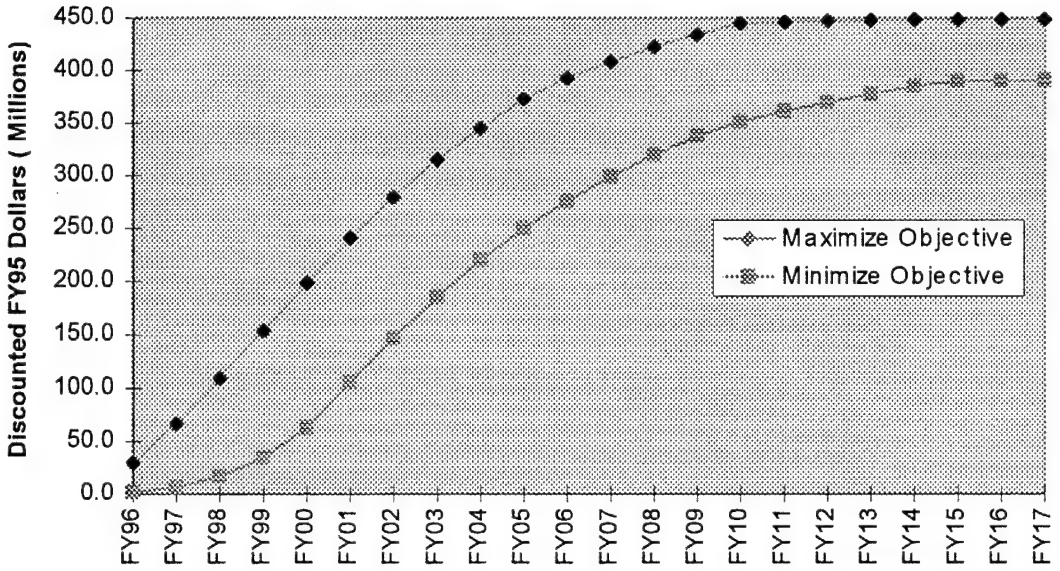

Figure 3-2. Cumulative Cost Savings/Avoidance over PPO Economic Lives (Case Study 1)

All PPO in the investment have consumed their economic lives by FY 17 (2017), and the cumulative CS/A achieved by this time represent the highest values of cumulative CS/A associated with each objective. As the graphs reach FY 17, the cumulative CS/A difference (on a discounted basis) is seen to approach $450M for the maximize objective and $390M for the minimize objective, for a cumulative CS/A difference of approximately $60M (see following paragraph for discussion of exact amounts). This difference highlights the economic advantage of the maximize vs minimize objective, and, by inference, the economic advantage of the maximize objective over any other formulations of prioritization which lie between these limits.

(3) Aggregate Cost Results. The aggregate investment cost and its associated cumulative CS/A for each CS/A objective are shown in Table 3-2, expressed in FY 95 discounted dollars. The cumulative CS/A for each objective is the summation of the CS/A for individual PPO, over their respective life cycles.

Table 3-2. Aggregate Results (Case Study 1)

Cost savings/avoidance objective	Investment cost (FY 96-01)`	Life cycle cost savings/avoidance
Maximize	**$80.4M**	**$448.9M**
Minimize	**$80.4M**	**$390.4M**

Discounted FY 95 dollars

For both objectives, the overall investment costs are the same, in the amount of $80.4M, since the investment was funded at the same level over the funding period. The differences in the life cycle CS/A reflect the difference in the acquisition sequence of the PPO between the maximize and minimize objectives. There would be no life cycle difference between the objectives if the life cycle CS/A were computed on a constant dollars basis since for both objectives all the PPO are acquired and accumulate the same life cycle benefit regardless of acquisition order. Only when the time value of money is considered does the order of acquisition, which controls the point in time of the CS/A benefit, become significant in generating a difference in the life cycle CS/A. This discounted difference reflects the contribution of the prioritization of the PPO acquisition, which prefers the PPO which are more economically efficient.

e. Observations on Comparison of P2 Investment Strategies. Use of discounting as an investment assessment tool provides the following insights.

(1) Timing of P2 Investments. When dollars are discounted, the investment strategy, in particular the timing of the P2 investments, significantly affects the life cycle CS/A of the investments.

(2) Bounds on Investment Strategies. When dollars are discounted, the maximize CS/A investment strategy, as contrasted with the minimize strategy, is clearly illustrated to have the preferred outcome of a higher CS/A. This implies that any other timing of P2 investments, as judged by this criteria, will lie between the bounds of these two limiting strategies.

3-5. CASE STUDY 2--INTEGRATED P2 INVESTMENT STRATEGY

a. Investment Issue. This case study integrates the PPO used in Case Study 1, with an investment in ECO. With this combination, the further CS/A possible due to less pollution from energy generation, as afforded by the ECO, are included. The ECO data set used in this analysis has been adapted from the data base used in the Synthesizing Energy Worth Study (Ref 2). The ECO characteristics (to include both energy efficient and renewable energy technologies) were developed by the US Army Construction Engineering Research Laboratory. Both the PPO and ECO generate pollution reduction benefits, but the amount and timing of these benefits are not presently evaluated for lack of PPO pollution reduction data (paragraph 3-3d(2)).

b. Investment Strategy Development. The investment conditions for Case Study 2 are shown in the following exhibit.

Investment Strategy Conditions--Case Study 2

Objective: Maximize cost savings/avoidance

Policy and Budget Parameters:
- ♦ Fund at level to acquire all opportunities
- ♦ Allocate investment in equal amounts over period FY 96-01

Assumptions and Constraints:
- ♦ Assign costs and benefits in year funded
- ♦ Benefits continue over funding period

Data Set Size:
- ♦ Number of PPO: 143
- ♦ Number of ECO: 78

Because of its detail, the investment strategy generated by PAPA is shown in Appendix E, Tables E-3 (for PPO acquired) and Table E-4 (for ECO acquired). In accordance with the investment condition for the case study to "fund at a level to acquire all opportunities," all the PPO and ECO available are acquired, except for those ECO which have paybacks of greater than 10 years, since such levels of payback are excluded from consideration by the Energy Policy Act of 1992.

c. Investment Strategy Evaluation. The evaluation of the investment strategy is conducted using three measures to characterize the investment and its results: (1) the annual investment costs--as they occur over the investment period of FY 96-01, (2) the annual CS/A--over the same investment period, and (3) the aggregate cost results--over the life cycle of the investments in PPO and ECO. The evaluation using these measures is described in the following.

(1) Annual Investment Costs. The annual investment costs are prescribed by the investment condition which calls for funding of all opportunities in equal amounts over the funding period of FY 96-01. The annual amounts involved for funding all the PPO and ECO are shown in the stacked bar chart in Figure 3-3. The mix of the investment funding between PPO and ECO in each year, and across the years, is generated by PAPA so as to maximize the CS/A, as prescribed by the investment strategy objective.

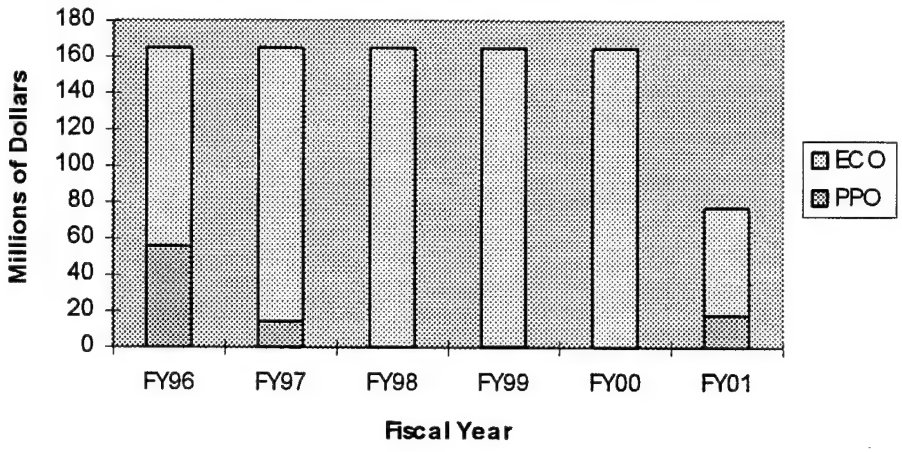

Figure 3-3. Annual Investment Costs (Case Study 2)

The amounts are in constant FY 95 dollars and are shown for both the PPO investment (bottom part of bar) and ECO investment (top part of bar). It will be noted that equal amounts are invested in each of the first 5 years at a level of $165 million and drops to $88 million in the last year.

This difference of $88M in the last year is due to the nature of the technology of some of the ECO, which allows acquisition of the most appropriate ECO when several are in competition for the same application. An example of this situation is one where a heat pump is in competition with a combination of furnace and air conditioner. The choice is determined by the range of temperature conditions in the area where the ECO is installed. Once the conditions are known, the ECO selection is established. This competitive aspect of some ECO was identified in an earlier study (Ref 2), and reflected in the present analysis. Following the earlier study methodology, the cost of all the ECO is included in the annual investment costs, as required by the investment condition to acquire all PPO and ECO. However, the effect of the competition is to preclude the acquisition of some ECO, and total cost associated with the precluded ECO is the $88M identified above.

Also apparent in the chart is the substantial difference in the spending levels for ECO and PPO, with the PPO level at approximately 10 percent of the total investment over FY 96-01. It can also be noted that the PPO investment principally occurs in the first 2 years of the investment period, where the economic benefit of the PPO is relatively high with respect to the ECO. This is followed by another PPO investment in the last FY, where the economic benefit of these latter PPO is comparable in magnitude to the ECO in the period.

(2) Annual Investment CS/A. The annual CS/A for the investment in PPO and ECO is shown in the stacked bar chart in Figure 3-4. The early investment in PPO in the first 2 years shown in Figure 3-4 converts into establishing an early CS/A which remains constant over the following years, since the additional PPO acquired in the last year (see Figure 3-2) contribute only a small CS/A. The ECO CS/A is seen to build gradually over time as additional ECO are acquired.

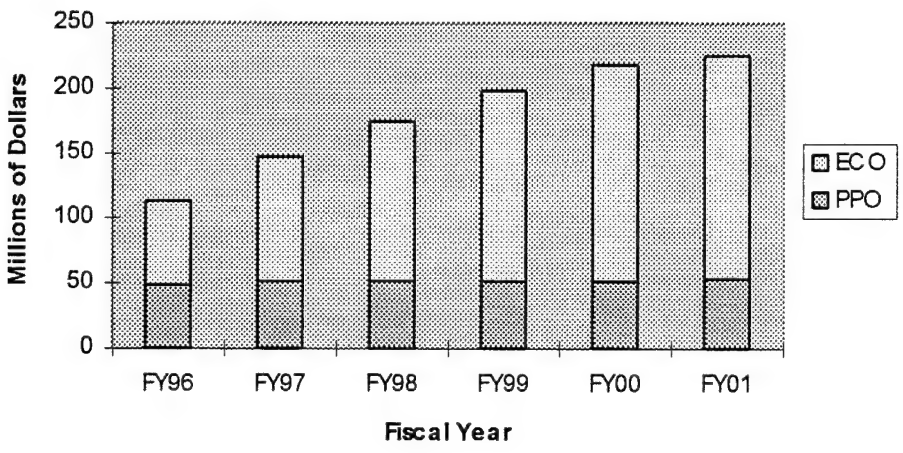

Figure 3-4. Annual Investment Cost Savings/Avoidance (Case Study 2)

The CS/A continue to accumulate over the life cycles of the individual PPO and ECO until the last opportunity is retired from service. The final, aggregate, life cycle CS/A on a constant FY 95 dollar basis are presented in the next paragraph.

(3) Aggregate Cost Results. The aggregate cost results for the integrated PPO/ECO investment are shown in Table 3-3 in FY 95 constant dollars. The investment in the PPO is shown as $88M, which is approximately 10 percent of the combined PPO/ECO investment of $903M. The life cycle CS/A of the PPO is $578M, which is approximately 16 percent of the combined CS/A, indicating that the PPO investment is more economically efficient. However, this economic efficiency analysis does not include the relative contribution of the PPO and ECO to pollution reduction. Both the PPO and ECO generate pollution reduction benefits, but the amount and timing of these benefits are not presently evaluated for lack of PPO pollution reduction data.

Table 3-3. Aggregate Results (Case Study 2)

Type of opportunity	Investment cost (FY 96-01)	Life cycle cost savings/avoidance
PPO	$88M	$578M
ECO	$815M	$3,002M
Total	$903M	$3,580M

Constant FY 95 dollars

d. Observations on Integrated P2 Investment Strategy

(1) Investment Timing. The investment in the PPO occur, for the most part, in the early part of the funding period, indicating that the PPO are more economical than the ECO and provide a relative CS/A advantage over the ECO both on an annual and aggregate basis.

(2) Policy Support. Policywise, however, the investment in ECO does not prevent releases that contribute to the 50 percent reduction in toxic releases required by EO 12856. The reductions generated by the ECO are for the nontoxic gases associated with energy production.

3-6. CASE STUDY 3--P2 INVESTMENT RESULTS AS INSTALLATION READINESS MEASURES

a. Investment Issue. This case of environmental investment assesses the pollution reduction provided by PPO in the context of the 50 percent reduction directed by EO 12856. For this case, the pollution reduction analysis from an earlier study (Ref 1), which examined the pollution reduction at eight Army industrial installations, was used. The present study uses the pollution reduction results for the industrial installation with the greatest pollution reduction, namely Corpus Christi Army Depot (CCAD). Using the results for this site, the reduction is assessed in terms of an installation environmental readiness measure, based on the use of C-rating color codes (Red-Yellow-Green). The C-rating concept is adopted from the C-rating usage in the HQDA ISR decision support system (Ref 5). The C-rating implemented herein is similar in concept, but used notionally with respect to the pollution reduction intervals associated with the colors. Defining the actual ranges associated with the color codes is beyond the scope of the present analysis.

b. Investment Strategy Development. The investment conditions for Case Study 3 are shown in the following exhibit.

Investment Strategy Conditions--Case Study 3

Objective: Maximize pollution reduction

Policy and Budget Parameters:

- ♦ Fund at level to acquire all opportunities
- ♦ Allocate investment in equal amounts over period FY 94-99

Assumptions and Constraints:

- ♦ Assign costs and benefits in year funded
- ♦ Benefits continue over funding period

Data Set Size:

- ♦ Number of PPO: 26
- ♦ Number of sites: 8 (Army industrial installations; the results for one, the Corpus Christi Army Depot, are used in this study)

The investment strategy as output from the PAPA Model is provided in Appendix E, Table E-5. In accordance with the investment condition to "fund at a level to acquire all opportunities," all the PPO for the eight Army industrial installations are acquired.

c. Investment Strategy Evaluation. The evaluation of the investment strategy differs from the Case 1 and 2 studies in that the strategy objective is to maximize pollution reduction and then address the manner in which this reduction can be measured in terms of installation environmental readiness. For this purpose, two measures are introduced: a measure in units of weight of the pollution reduction, and a measure falling within a weight range corresponding to a C-rating.

(1) Pollution Reduction Measured by Pollutant Weight. The most direct measure of pollution reduction in support of EO 12856 is a graph of the trend line showing the pollutant weight reduction over time, as the investment in pollution prevention technology is made over time. This weight-based measure in consistent with the EO 12856, which mandates a reduction by pollutant weight only, not by pollutant type. In accordance with the investment conditions, the pollution reduction benefit from the investment starts the year in which the investment is made. For this method of assignment of benefits, the investment strategy used in Case Study 3 produces the pattern of reduction in pollution shown in Figure 3-5. It is apparent in the figure that the EO 12856 mandate of a 50 percent reduction in pollution generation is achieved at CCAD by the target year of 1999, when the pollutant weight curve meets the goal weight line. Note that there is an immediate drop in the pollutant generation in FY 94 below FY 94 baseline due to the investment in PPO in that year. This is an artifact of the operation of the model, under the assumption that benefits are assigned in the year the PPO is funded.

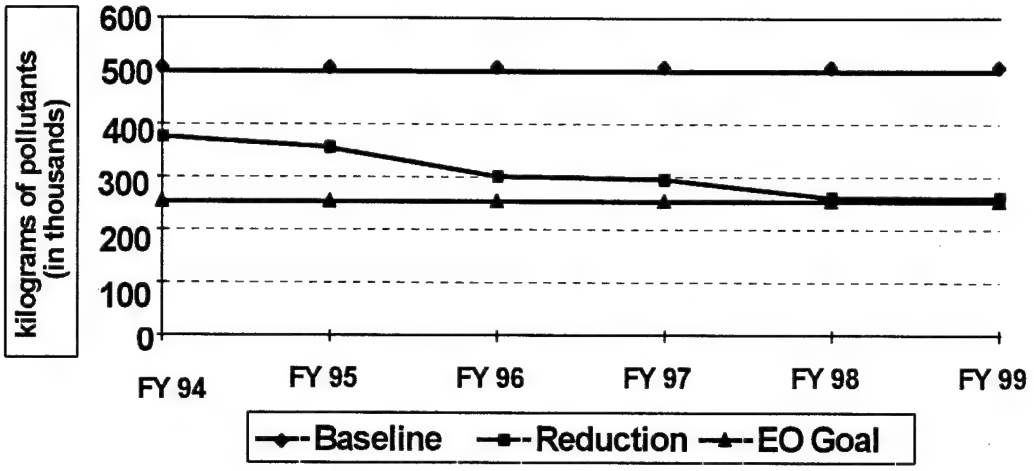

Figure 3-5. Pollution Reduction at CCAD Expressed in Pollutant Weight

(2) Pollution Reduction Measured by C-rating. The measurement of pollution in units of pollution can be directly translated into measures of C-rating by establishing ranges corresponding to the C-ratings. The ranges partition the pollution reduction scale between the FY 1994 baseline condition (year specified in EO 12856) and the point of the scale corresponding to the reduction goal of 50 percent (goal specified in EO 12856). The result of overlaying the pollution reduction ranges on the graphed results in Figure 3-5 for CCAD are shown in Figure 3-6. The pollution ranges for the C-ratings are notional and have been selected to divide the baseline-to-goal interval into four, approximately equal, steps. This assignment of ranges is presented as illustrative of the process. The selection of the actual numerical ranges for operational use remains to be determined by other analysis.

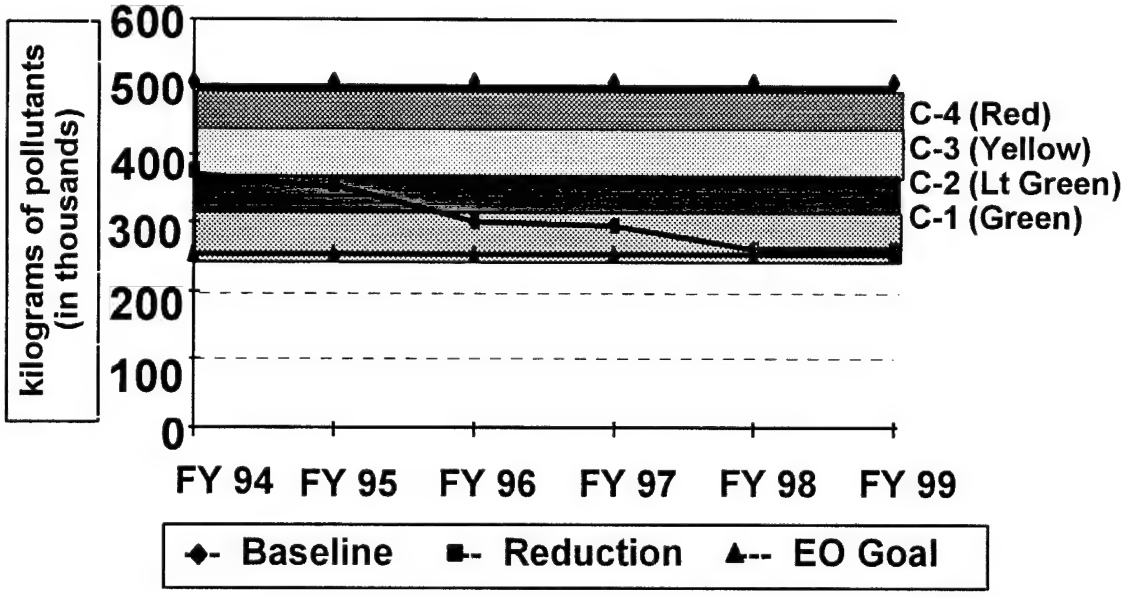

Figure 3-6. Pollution Reduction at CCAD Interpreted as C-rating Measure

The use of color to identify the C-rating bands is drawn directly from the ISR methodology (Ref 5). In this methodology, the poorest pollutant reduction condition is designated C-4 and is coded Red, the next higher pollutant reduction condition is designated C-3 and is coded Amber, the next higher pollutant reduction is designated condition C-2 and is coded Lt (light) Green, and the highest (best) pollutant reduction condition is designated C-1 and is coded Green. In this report, color is not used, and the colors referenced in Figure 3-6 are represented by shades of gray.

d. Observations on P2 Investment Results as Installation Readiness Measures

(1) Definition of Measure. As illustrated in Figure 3-6, the results of the investment in PPO over the investment period can be portrayed as a curve of the pollution reduction over time. For each year, the extent of the reduction can be compared with the baseline amount for that year, and results expressed as falling within a band of color, corresponding to a C-rating.

(2) Applications of Measure. This approach provides individual installation readiness measures by FY over the funding period of interest. These measures are suitable for assessing:

(a) Installation Environmental Improvement. The C-rating for the last FY in the funding period measures the environmental improvement achieved at an installation as a result of the PPO investment over the funding period.

(b) MACOM and Army Environmental Improvement. The aggregation of C-ratings across the installations within a MACOM becomes a measure of the MACOM environmental improvement. A corresponding aggregation of the MACOM measures across the Army becomes a measure of the Army environmental improvement. These aggregated measures can contribute to the comparison of alternative P2 investment strategies.

3-7. DEVELOPMENT OF PHASE II DATA BASE. During the course of the work on Phase I, it was anticipated that the required data would become available from one or both of the following efforts, addressing the collection of P2 project data.

a. Pollution Prevention Plans. The first, and larger, effort was the Army program to develop facility pollution prevention plans (P2 plans), no later than the end of 1995, as mandated by EO 12856. The plans, as completed toward the end of the year, were forwarded to ODEP for review. However, the review of the P2 plans concluded that they did not provide a complete and consistent set of P2 project cost and benefit data for use with the PAPA methodology.

b. ODEP Supporting Data Call. The other effort, was the call for inclusion of the data as part of the P2 submissions for Fall 1995 update of the Army environmental program requirements (EPR). ODEP had requested the MACOM, on a voluntary basis, to include as supporting requirements the P2 project cost and benefit data for use with the PAPA methodology. However, as with the P2 plans data, the review of the submitted EPR data submissions did not provide a complete and consistent set of P2 project cost and benefit data.

3-8. PERSEUS STUDY STATUS. As a consequence of the unavailability of the required P2 data, work on PERSEUS Study was concluded with Case Studies 1, 2, and 3 (Table 2-1) which used the limited Phase I data base. The study results for Phase I are documented in this report. Work on Case Studies 4, 5, and 6 (Table 2-2), which require a full and validated data set were not completed. Contingent upon development of a data base with these CS/A and pollution reduction benefits data, an analysis of P2 investment strategies using the PAPA methodology should be conducted.

APPENDIX A

STUDY CONTRIBUTORS

1. STUDY TEAM

a. Study Director

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APPENDIX B

STUDY DIRECTIVE

DEPARTMENT OF THE ARMY
ASSISTANT CHIEF OF STAFF FOR INSTALLATION MANAGEMENT
600 ARMY PENTAGON
WASHINGTON DC 20310-0600

REPLY TO ATTENTION OF

2 DEC 1994

DAIM-ED-P2 (5-5d)

MEMORANDUM FOR DIRECTOR, U.S. ARMY CONCEPTS ANALYSIS AGENCY, ATTN: CSCA-RSR, 8120 WOODMONT AVENUE, BETHESDA, MD 20814-2797

SUBJECT: Planning Environmental Resource Strategy Evolution and Utilization Study (PERSEUS)

1. PURPOSE OF STUDY DIRECTIVE. This directive tasks the U.S. Army Concepts Analysis Agency (CAA) to use the Pollution Abatement and Prevention analysis (PAPA) methodology to formulate and analyze investment strategies that support Army environmental policy and program requirements.

2. STUDY TITLE. Planning Environmental Resource Strategy Evolution and Utilization Study (PERSEUS)

3. BACKGROUND:

a. The Pollution Prevention Act of 1990 declared it national policy that pollution be prevented or reduced at the source, otherwise recycled in a safe manner. The Act further directed the filing of annual toxic chemical source reduction and recycling reports. In furtherance of this policy, Executive Order 12856, "Pollution Prevention and Right-to-Know" directed a 50 percent reduction (from 1994 baseline) of toxic chemical releases by Federal agencies by 1999.

b. The Energy Policy Act of 1992 declared it national policy that all energy efficient and renewable energy measures that payback in 10 years of less be implemented by 2005. In furtherance of this policy, Executive Order 12902, "Energy Efficiency and Water conservation" directs development and implementation of a program for increase in energy efficiency by Federal agencies by 30 percent (from 1985 baseline) by 2005, as measured per gross square foot of the agency's buildings in use.

c. The Secretary of Defense (SECDEF) in a memorandum dated 11 August 1993, directed the military services to submit detailed milestone plans to "improve the Department of Defense environmental performance by actively implementing policies that embrace pollution prevention in all phases of the acquisition process, the procurement of goods and services and in life-cycle management at our installations". The SECDEF memorandum enclosed

a strategy document which incorporates the requirements of Executive Orders 12856, 12873 (Federal Acquisition, Recycling and Waste Prevention) and 12902, as well as recommendations from the Deputy Under Secretary of Defense (Acquisition Reform) Process Action Team report on "Blue Print for Change."

d. In responding to this guidance, the Army requires a quick turnaround decision support capability, as provided by the PAPA methodology, to systematically develop and evaluate the most effective pollution prevention investments.

4. STUDY SPONSOR. The Assistant Chief of Staff for Installation Management (ACSIM).

5. TERMS OF REFERENCE:

a. Purpose. To formulate and analyze investment strategies that support Army environmental policy and program requirements.

b. Definitions. For the purposes of this study, the following definitions apply:

(1) Investment Strategy. An analytically based plan for acquisition of environmental projects which identifies the projects to be bought in each fiscal year (FY) and the installations for which they are bought.

(2) Pollution Abatement. The use of materials, processes, or practices that reduce the degree or intensity of pollution for eliminating pollution entirely.

(3) Pollution Prevention. The use of materials, processes or practices that reduce or eliminate the creation of pollutants or wastes at the sources.

(4) Toxic Materials. Includes, but is not necessarily limited to, the toxic chemicals identified in Section 313(c) of the Emergency Planning and Community Right-to-Know Act of 1986. Federal agencies may also include as toxic pollutants, releases of other chemicals deemed hazardous wastes or hazardous air pollutants under other Statutes.

(5) Pollution Prevention Opportunity (PPO). A technology, process, material, or procedure which, when used, installed, or substituted for an existing method will prevent, eliminate or reduce the generations of pollution.

(6) Energy Conservation Opportunity (ECO). An energy source or technology which, when used, installed, or substituted for an existing method, will reduce the consumption of energy at the location of the ECO and/or at the (remote) location where the power associated with the existing ECO is generated.

c. SCOPE:

(1) The study will be conducted in two phases. Phase 1 will use the PAPA methodology with an Initial Data Set developed from the most immediately accessible PPO/ECO data. Phase 2 will use the PAPA methodology with a Revised Data Set reflecting adjustments and additions to the Initial Data Set.

(2) The investment strategies will identify PPOs and ECOs by type, number, installation and FY of acquisition.

(3) The strategies will consider off-the-shelf PPO/ECO technologies.

(4) The strategies will address the overall time period of FY 1994-2005, and include F periods of interest, as appropriate.

(5) The study will consider Army installations in the U.S. only, to include the U.S. Army Material Command, the Forces Command, and the U.S. Army Training and Doctrine Command.

d. Objectives. The study will:

(1) Develop PPO data for Army installation in the U.S.A.

(2) Apply the PAPA investment model to generate and analyze:

(a) Pollution prevention investment strategies in response to Executive Order 12856.

(b) Integrated pollution prevention energy conservation investment strategies in response to the SECDEF memorandum (paragraph 3.c).

(3) Relate investment strategy results to measures of installation readiness reflecting contribution towards environmental goals.

DAIM-ED-P2 (5-5d)
SUBJECT: Planning Environmental Resource Strategy Evolution and Utilization Study (PERSEUS)

6. RESPONSIBILITIES:

a. The Study Sponsor (ACSIM) will:

(1) Designate the U.S. Army Environmental Center (AEC) as the activity with primary responsibility for development of the PPO data for use in the study.

(2) Provide a study point of contact.

(3) Establish a Study Advisory Group (SAG). Schedule in-process reviews as required.

(4) Authorize CAA to conduct direct communication with HQDA and other organizations required for conduct of the study.

(5) Prepare evaluation of study results IAW AR 5-5.

b. The Study Agency (CAA) will:

(1) Designate a study director and establish a full-time study team.

(2) Establish direct communication with HQDA, and other organizations required for the conduct of the study.

(3) Provide in-process reviews as requested, and final study report to the study sponsor.

7. ADMINISTRATION:

a. CAA will provide all administrative support necessary for conduct for the study

b. Milestone Schedule:

Approval of Study Directive.....Nov 1994
In-process Reviews.....As required
Present Study Results.....Nov 1995
Publish Final Report.....Jan 1996

c. ACSIM, in coordination with CAA, will prepare the initial DD Form 1498, Research and Technology Work Unit Summary.

d. CAA will provide study results to the study sponsor as a study report.

DAIM-ED-P2 (5-5d)
SUBJECT: Planning Environmental Resource Strategy Evolution and Utilization Study (PERSEUS)

e. CAA will submit the final, approved study report to Defense Technical Information Center (DTIC).

f. This tasking has been coordinated with CAA IAW paragraph 4, AR 10-3, United States Army Concepts Analysis Agency.

8. The point of contact for this action is Kathleen O'Halloran, 696-8814.

JOHN H. LITTLE
Major General, GS
Assistant Chief of Staff for
Installation Management

APPENDIX C

REFERENCES

1. US Army Concepts Analysis Agency, Pollution Abatement and Prevention Analysis (PAPA) Study, CAA-SR-94-6, July 1994

2. US Army Concepts Analysis Agency, Synthesizing Energy Worth (SEW) Study, CAA-SR-95-8, June 1995

3. Assistant Chief of Staff for Installation Management (DAIM-ED-P2), memorandum, Pollution Prevention Funding Estimates POM 97-01, 12 December 1994

4. Department of the Army, Office of the Assistant Secretary (Financial Management and Comptroller) (ASA-FM&C), memorandum, Revision to Discount Rates for Use in Economic Analysis (EA), 3 March 1995

5. HQDA, Installation Status Report (ISR) Decision Support System (updated annually)

6. HQDA, Office of Environmental Programs, Policy Guidance for Identifying US Army Environmental Program Requirements, 20 December 1995

APPENDIX D

PHASE I DATA BASE

D-1. INTRODUCTION. This appendix provides a listing of the PPO, generated by the data collection effort during Phase I of the PERSEUS Study, described in the main body of the report. For the purposes of the PERSEUS Phase I analysis, the PPO were collected at the MACOM level. More typically, the data would be collected at the installation level. This was not feasible for Phase I, but would be the practice in Phase II of the study.

D-2. DATA BASE DESCRIPTION. The data base consists of PPO grouped by MACOM. For each PPO, the following items of data are identified for use with the PAPA methodology:

a. PPO Name. A descriptive name for the PPO.

b. MACOM. Major Army command where the PPO investment is required.

c. Quantity (Qty). The number of this PPO required (all installations in MACOM).

d. Total Cost (K$). The total cost for number of this PPO required, in thousands of dollars.

e. Total Cost Saving/Avoidance (Tot Cost Svg/Avd (K$)). The total cost savings/avoidance for number of this PPO required, in thousands of dollars.

f. Econ Life (Years). The economic (useful) life in years for this PPO. The value of the economic life must be at least equal to the duration of the FY planning period to be compatible with the benefit assumptions incorporated in the PAPA methodology.

Table D-1. Phase I Data Base
(page 1 of 4 pages)

	PPO name	MACOM	Qty	Total cost (K$)	Tot cost svg/avd (K$)	Econ life (years)
1	Absorbent pad squeezer	8thArmy	20	$44	$22	6
2	Activated carbon fuel filter/drum	8thArmy	25	$220	$73	6
3	Aerosol can puncher	8thArmy	20	$66	$33	6
4	Anti-freeze recycler	8thArmy	6	$92	$15	10
5	Bead blast cleaner	8thArmy	13	$43	$29	6
6	Dustless sanders	8thArmy	20	$44	$18	6
7	Engine oil by-pass filter system	8thArmy	52	$458	$114	6
8	Fiberglass & metal bonding unit	8thArmy	4	$79	$26	6
9	Freon recycler	8thArmy	23	$202	$135	6
10	Hazardous waste compactor	8thArmy	7	$92	$31	6
11	High pressure water stripper	8thArmy	10	$264	$132	6
12	Paint gun cleaning machine	8thArmy	33	$109	$27	6
13	Spill cleanup equipment	8thArmy	36	$40	$13	6
14	Spill control equipment	8thArmy	1	$88	$29	6
15	Caustic cleaning bldg upgradei	AMC	1	$440	$44	15
16	CFC/Halon reduction project	AMC	1	$396	$40	10
17	Close loop waste wtr fr electplt shp	AMC	1	$330	$33	10
18	CO2 depainting system	AMC	1	$110	$22	10
19	Complete chrme recovery bldg 212	AMC	1	$110	$22	10
20	Consrt walled tst fire pit with sump	AMC	1	$286	$29	10
21	Conv of expl cmpd D to picric acid	AMC	1	$220	$22	10
22	Cooling water recycle waste min	AMC	1	$165	$33	10
23	Environmental chamber retrofit	AMC	1	$165	$17	10
24	HAZMIN closed loop cooling	AMC	1	$51	$25	10
25	HAZMIN CTX spray rinse-pltg tnks	AMC	1	$55	$11	10
26	HAZMIN envr optm metal finishing	AMC	1	$5,500	$1,100	15
27	HAZMIN:atomtd paint strp acft sys	AMC	1	$3,300	$660	15
28	HAZMIN:CTX chiller-pltg tnks	AMC	1	$13	$6	10
29	HAZMIN:CTX elctrdyls pltg tnks	AMC	1	$288	$144	10
30	HAZMIN:CTX electrowin-pltg tnks	AMC	8	$158	$63	10
31	HAZMIN:CTX hi pr wtr eqp-pet solv	AMC	3	$264	$132	10
32	HAZMIN:CTX proc purfctn conv coat	AMC	3	$135	$193	10
33	HAZMIN:CTX spray rinse pltg tnks	AMC	50	$292	$324	10
34	HAZMIN:CTX spray rinse pltg tnks	AMC	35	$208	$122	10
35	HAZMIN:Paint solvent rcvry sys	AMC	1	$77	$15	10
36	HAZMIN:permanganate clnr regen	AMC	1	$440	$88	10

Table D-1. Phase I Data Base
(page 2 of 4 pages)

	PPO name	MACOM	Qty	Total cost (K$)	Tot cost svg/avd (K$)	Econ life (years)
37	HAZMIN:pltg rinse for ion exch col	AMC	1	$220	$44	10
38	HM storage units	AMC	1	$44	$4	10
39	Install solvent recovery unit	AMC	1	$20	$4	10
40	Install water saving devices	AMC	1	$138	$14	10
41	Ion vapor deposition of aluminum	AMC	1	$804	$884	10
42	New abrasive blstg eqp (sm arms)	AMC	1	$220	$44	10
43	Oil/water separator for blgd 200-D	AMC	1	$220	$22	10
44	OWS for track hardstand	AMC	1	$28	$3	10
45	Plant trees for NDPES outfalls	AMC	1	$29	$3	15
46	Purchase and install barrel crusher	AMC	1	$44	$9	10
47	Recycle wash booth wash water	AMC	1	$83	$17	10
48	Reinsulate heat exchngrs-blgd 212	AMC	1	$83	$17	10
49	Replace vapor degreaser	AMC	1	$110	$22	10
50	Smoke mix extraction project	AMC	1	$440	$183	20
51	Steam condensate return system	AMC	1	$164	$33	15
52	Varsol reclaimation unit	AMC	1	$154	$31	10
53	Antifreeze recycler	ARNG	324	$2,851	$1,426	10
54	Jet pressure washer	ARNG	324	$8,197	$4,314	10
55	Non solvent parts washer	ARNG	324	$4,883	$8,138	15
56	Antifreeze recyc machs for site	FORSC	19	$7,629	$2,825	10
57	HVLP spray guns for paint shop	FORSC	19	$523	$746	6
58	Solargizers for site	FORSC	19	$15,675	$7,838	6
59	Replace inefficient HVAC equip	MDW	1	$880	$88	15
60	Retrofit/replace lighting fixtures	MDW	1	$209	$42	10
61	AC freon recvry unit-big base	TRADOC	13	$286	$29	10
62	AC freon recvry unit-small base	TRADOC	5	$55	$6	10
63	Alum can compactor-big base	TRADOC	13	$129	$26	10
64	Alum can compactor-small base	TRADOC	5	$50	$10	10
65	Antifreeze recycler-big base	TRADOC	13	$558	$279	10
66	Antifreeze recycler-small base	TRADOC	5	$36	$18	10
67	Bead blaster-big base	TRADOC	13	$72	$286	10
68	Bead blaster-small base	TRADOC	5	$14	$55	10
69	Cardboard baler-big base	TRADOC	13	$129	$26	10
70	Cardboard baler-small base	TRADOC	5	$50	$10	10
71	Drum cleaning unit-big base	TRADOC	13	$229	$2,757	10
72	Drum cleaning unit-small base	TRADOC	5	$44	$530	10

Table D-1. Phase I Data Base
(page 3 of 4 pages)

	PPO name	MACOM	Qty	Total cost (K$)	Tot cost svg/avd (K$)	Econ life (years)
73	Drum crusher-big base	TRADOC	13	$429	$29	10
74	Drum crusher-small base	TRADOC	5	$83	$6	10
75	Electrolytic silver recvry-big base	TRADOC	13	$501	$250	10
76	Electrolytic silver recvry-small base	TRADOC	5	$193	$96	10
77	Electrostatic paint sys-big base	TRADOC	13	$343	$412	10
78	Electrostatic paint sys-small base	TRADOC	5	$66	$79	10
79	Explosive proof fuel vac-big base	TRADOC	13	$243	$203	6
80	Explosive proof fuel vac-small base	TRADOC	5	$47	$39	6
81	Flor lamp disposal unit-big base	TRADOC	13	$72	$29	10
82	Flor lamp disposal unit-small base	TRADOC	5	$28	$11	10
83	Fluid evacuator-big base	TRADOC	13	$72	$72	6
84	Fluid evacuator-small base	TRADOC	5	$8	$8	6
85	Fuel bowser-big base	TRADOC	13	$229	$69	10
86	Fuel bowser-small base	TRADOC	5	$22	$7	10
87	Gauge for lub drums-big base	TRADOC	13	$15	$30	10
88	Gauge for lub drums-small base	TRADOC	5	$2	$3	10
89	HVLP paint equipment-large base	TRADOC	13	$107	$358	6
90	HVLP paint equipment-small base	TRADOC	5	$17	$55	6
91	Lub dispensing system-big base	TRADOC	13	$265	$38	10
92	Lub dispensing system-small base	TRADOC	5	$41	$6	10
93	Non solv parts washer-big base	TRADOC	13	$4,891	$8,151	15
94	Non solv parts washer-small base	TRADOC	5	$754	$1,256	15
95	Oil analysis unit-big base	TRADOC	13	$386	$386	10
96	Oil analysis unit-small base	TRADOC	5	$50	$50	10
97	Oil filter crusher-big base	TRADOC	13	$150	$128	10
98	Oil filter crusher-small base	TRADOC	5	$19	$16	10
99	Oil filtration system-big base	TRADOC	13	$215	$143	6
100	Oil filtration system-small base	TRADOC	5	$83	$55	6
101	Paint booth	TRADOC	15	$578	$2,888	10
102	Paint gun washer-big base	TRADOC	13	$43	$252	6
103	Paint gun washer-small base	TRADOC	5	$6	$32	6
104	PCB ballast recycling	TRADOC	15	$660	$132	6
105	Recyc bins/containers-big base	TRADOC	13	$143	$43	10
106	Recyc bins/containers-small base	TRADOC	5	$28	$8	10
107	Solvent distillation unit-big base	TRADOC	13	$72	$34	10
108	Solvent distillation unit-small base	TRADOC	5	$28	$13	10

Table D-1. Phase I Data Base
(page 4 of 4 pages)

	PPO Name	MACOM	Qty	Total Cost (K$)	Tot Cost Svg/Avd (K$)	Econ Life (Years)
109	Spill pad wringer-big base	TRADOC	13	$79	$66	10
110	Spill pad wringer-small base	TRADOC	5	$12	$10	10
111	Stage II vapor recovery-big base	TRADOC	13	$1,823	$365	10
112	Stage II vapor recovery-small base	TRADOC	5	$187	$37	10
113	Used oil storage	TRADOC	15	$413	$41	10
114	Var ratio prop paint sys-big base	TRADOC	13	$393	$393	6
115	Var ratio prop paint sys-small base	TRADOC	5	$151	$151	6
116	VOC container	TRADOC	15	$2,805	$281	10
117	Automated chemical tracking sys	USACE	1	$28	$28	6
118	Freon replacement	USACE	1	$94	$9	10
119	Halon system replacement	USACE	1	$83	$8	10
120	Replace halon fire extingr sys	USAPAC	1	$330	$33	10
121	Replace halon sys with CO2 sys	USAPAC	2	$2,400	$240	10
122	Solvent substitution	USAPAC	3	$462	$462	10
123	Update AC & refrig equip	USAPAC	1	$2,200	$220	10
124	Above ground fuel tank cover	USAR	1	$4	$2	6
125	Above ground storage tanks	USAR	2	$55	$6	10
126	CFC/Halon phase-out	USAR	6	$165	$17	15
127	CFC/Halon phase-out	USAR	6	$660	$66	15
128	CFC/Halon phase-out	USAR	11	$242	$24	15
129	Containment pallets	USAR	6	$33	$7	6
130	Cross connection preventors	USAR	1	$110	$11	10
131	Fluid backflow preventors	USAR	6	$132	$13	10
132	HW spill response equip	USAR	6	$13	$4	6
133	HW storage lockers	USAR	3	$33	$3	10
134	Used solvent recovery	USAR	6	$178	$356	10
135	Waste water recycling equipment1	USAR	6	$13	$3	10
136	Waste water recycling equipment2	USAR	6	$13	$3	10
137	Halon system replacement1	USMA	1	$24	$2	10
138	Halon system replacement2	USMA	6	$1,300	$130	10
139	Halon system replacement3	USMA	11	$1,464	$146	10
140	Halon system replacement4	USMA	5	$336	$34	10
141	Halon system replacement5	USMA	5	$963	$96	10
142	Recycleables baler	USMA	1	$17	$3	10
143	Solvent degreaser replacement	USMA	12	$23	$92	15
	TOTALS			$88,255	$53,372	

APPENDIX E

CASE STUDY INVESTMENT STRATEGIES

E-1. INTRODUCTION. This appendix provides listings of the investment strategies produced by each of the three cases of investment considered in Phase I of the PERSEUS Study.

E-2. INVESTMENT STRATEGY DESCRIPTION. For each of the three case strategies developed, the following are identified.

- **Reference (Ref).** A running count of the PPO/ECO, for reference purposes.
- **PPO/ECO Name.** A descriptive name for the PPO/ECO.
- **MACOM.** Major Army command where the PPO investment is required.
- **Fiscal Year (FY) (sequence).** The range of fiscal years over which the investment in the PPO/ECO may be made under the investment objective. Nonzero entries under individual FY identify the quantity of the PPO/ECO investment in that year as follows:

  - ***Single Year Investment.*** If there is only one PPO/ECO investment made in the planning period, the first nonzero entry is the quantity acquired, and the value remains fixed at this value over the balance of the fiscal years.

  - ***Multiple Year Investment.*** If there are multiple PPO/ECO investments made over the planning period, the first nonzero entry is the quantity acquired in that year. This value accumulates as additional PPO/ECO are acquired in the remaining years. As the value accumulates, the number of PPO/ECO acquired in a particular year is the difference between the value that year and the value in the preceding year.

e. Shaded Entries. Shading is used in Tables E-1 and E-2 to identify the PPO which are cited and discussed in the main body of the report.

E-3. CASE STUDY TABLES. The tables in this appendix associated with the case studies are shown below. For Tables E-1 to E-4 the dollars are expressed in thousands of FY 95 dollars. For Table E-5 the dollars are expressed in thousands of FY 94 dollars.

Table	Case	Description	#pages	Page
E-1	1	P2 Investment Strategy Comparison (Max CS/A)	4	E-2
E-2	1	P2 Investment Strategy Comparison (Min CS/A)	4	E-6
E-3	2	Integrated P2 Investment Strategy (PPO)	4	E-10
E-4	2	Integrated P2 Investment Strategy (ECO)	2	E-14
E-5	3	P2 Investment Results as Readiness Measures	1	E-16

Table E-1. Case Study 1--P2 Investment Strategy Comparison (Max CS/A)
(page 1 of 4 pages)

Ref	PPO name	MACOM	fy96	fy97	fy98	fy99	fy00	fy01
1	Absorbent pad squeezer	8thArmy	0	20	20	20	20	20
2	Activated carbon fuel filter/drum	8thArmy	0	0	0	25	25	25
3	Aerosol can puncher	8thArmy	0	20	20	20	20	20
4	Anti-freeze recycler	8thArmy	0	0	0	0	6	6
5	Bead blast cleaner	8thArmy	0	13	13	13	13	13
6	Dustless sanders	8thArmy	0	0	20	20	20	20
7	Engine oil by-pass filter system	8thArmy	0	0	0	52	52	52
8	Fiberglass & metal bonding unit	8thArmy	0	0	0	4	4	4
9	Freon recycler	8thArmy	0	23	23	23	23	23
10	Hazardous waste compactor	8thArmy	0	0	0	7	7	7
11	High pressure water stripper	8thArmy	0	10	10	10	10	10
12	Paint gun cleaning machine	8thArmy	0	0	0	33	33	33
13	Spill cleanup equipment	8thArmy	0	0	0	36	36	36
14	Spill control equipment	8thArmy	0	0	0	1	1	1
15	Caustic cleaning blgd upgradei	AMC	0	0	0	0	1	1
16	CFC/Halon reduction project	AMC	0	0	0	0	1	1
17	Close loop waste wtr fr electplt shp	AMC	0	0	0	0	1	1
18	CO2 depainting system	AMC	0	0	0	1	1	1
19	Complete chrme recovery blgd 212	AMC	0	0	0	1	1	1
20	Consrt walled tst fire pit with sump	AMC	0	0	0	0	1	1
21	Conv of expl cmpd D to picric acid	AMC	0	0	0	0	0	1
22	Cooling water recycle waste min	AMC	0	0	0	1	1	1
23	Environmental chamber retrofit	AMC	0	0	0	0	1	1
24	HAZMIN closed loop cooling	AMC	0	0	1	1	1	1
25	HAZMIN CTX spray rinse-pltg tnks	AMC	0	0	0	1	1	1
26	HAZMIN envr optm metal finishing	AMC	0	0	0	0	1	1
27	HAZMIN:atomtd paint strp acft sys	AMC	0	0	0	1	1	1
28	HAZMIN:CTX chiller-pltg tnks	AMC	0	0	1	1	1	1
29	HAZMIN:CTX elctrdyls pltg tnks	AMC	0	1	1	1	1	1
30	HAZMIN:CTX electrowin-pltg tnks	AMC	0	0	8	8	8	8
31	HAZMIN:CTX hi pr wtr eqp-pet solv	AMC	0	3	3	3	3	3
32	HAZMIN:CTX proc purfctn conv coat	AMC	3	3	3	3	3	3
33	HAZMIN:CTX spray rinse pltg tnks	AMC	50	50	50	50	50	50
34	HAZMIN:CTX spray rinse pltg tnks	AMC	0	35	35	35	35	35
35	HAZMIN:Paint solvent rcvry sys	AMC	0	0	0	1	1	1
36	HAZMIN:permanganate clnr regen	AMC	0	0	0	1	1	1

Table E-1. Case Study 1--P2 Investment Strategy Comparison (Max CS/A)
(page 2 of 4 pages)

Ref	PPO name	MACOM	fy96	fy97	fy98	fy99	fy00	fy01
37	HAZMIN:pltg rinse for ion exch col	AMC	0	0	0	0	1	1
38	HM storage units	AMC	0	0	0	0	1	1
39	Install solvent recovery unit	AMC	0	0	0	1	1	1
40	Install water saving devices	AMC	0	0	0	0	1	1
41	Ion vapor deposition of aluminum	AMC	1	1	1	1	1	1
42	New abrasive blstg eqp (sm arms)	AMC	0	0	0	0	1	1
43	Oil/water separator for blgd 200-D	AMC	0	0	0	0	1	1
44	OWS for track hardstand	AMC	0	0	0	0	1	1
45	Plant trees for NDPES outfalls	AMC	0	0	0	0	0	1
46	Purchase and install barrel crusher	AMC	0	0	0	0	1	1
47	Recycle wash booth wash water	AMC	0	0	0	1	1	1
48	Reinsulate heat exchngrs-blgd 212	AMC	0	0	0	1	1	1
49	Replace vapor degreaser	AMC	0	0	0	1	1	1
50	Smoke mix extraction project	AMC	0	0	1	1	1	1
51	Steam condensate return system	AMC	0	0	0	0	1	1
52	Varsol reclaimation unit	AMC	0	0	0	1	1	1
53	Antifreeze recycler	ARNG	0	324	324	324	324	324
54	Jet pressure washer	ARNG	0	324	324	324	324	324
55	Non solvent parts washer	ARNG	324	324	324	324	324	324
56	Antifreeze recyc machs for site	FORSC	0	0	5	19	19	19
57	HVLP spray guns for paint shop	FORSC	19	19	19	19	19	19
58	Solargizers for site	FORSC	0	4	19	19	19	19
59	Replace inefficient HVAC equip	MDW	0	0	0	0	1	1
60	Retrofit/replace lighting fixtures	MDW	0	0	0	0	1	1
61	AC freon recvry unit-big base	TRADOC	0	0	0	0	13	13
62	AC freon recvry unit-small base	TRADOC	0	0	0	0	5	5
63	Alum can compactor-big base	TRADOC	0	0	0	13	13	13
64	Alum can compactor-small base	TRADOC	0	0	0	0	5	5
65	Antifreeze recycler-big base	TRADOC	0	0	13	13	13	13
66	Antifreeze recycler-small base	TRADOC	0	0	5	5	5	5
67	Bead blaster-big base	TRADOC	13	13	13	13	13	13
68	Bead blaster-small base	TRADOC	5	5	5	5	5	5
69	Cardboard baler-big base	TRADOC	0	0	0	0	13	13
70	Cardboard baler-small base	TRADOC	0	0	0	0	5	5
71	Drum cleaning unit-big base	TRADOC	13	13	13	13	13	13
72	Drum cleaning unit-small base	TRADOC	5	5	5	5	5	5

Table E-1. Case Study 1--P2 Investment Strategy Comparison (Max CS/A)
(page 3 of 4 pages)

Ref	PPO name	MACOM	fy96	fy97	fy98	fy99	fy00	fy01
73	Drum crusher-big base	TRADOC	0	0	0	0	0	13
74	Drum crusher-small base	TRADOC	0	0	0	0	0	5
75	Electrolytic silver recvry-big base	TRADOC	0	13	13	13	13	13
76	Electrolytic silver recvry-small base	TRADOC	0	0	5	5	5	5
77	Electrostatic paint sys-big base	TRADOC	13	13	13	13	13	13
78	Electrostatic paint sys-small base	TRADOC	**5**	**5**	**5**	**5**	**5**	**5**
79	Explosive proof fuel vac-big base	TRADOC	3	13	13	13	13	13
80	Explosive proof fuel vac-small base	TRADOC	5	5	5	5	5	5
81	Flor lamp disposal unit-big base	TRADOC	0	0	13	13	13	13
82	Flor lamp disposal unit-small base	TRADOC	0	0	5	5	5	5
83	Fluid evacuator-big base	TRADOC	13	13	13	13	13	13
84	Fluid evacuator-small base	TRADOC	5	5	5	5	5	5
85	Fuel bowser-big base	TRADOC	0	0	0	13	13	13
86	Fuel bowser-small base	TRADOC	0	0	0	5	5	5
87	Gauge for lub drums-big base	TRADOC	13	13	13	13	13	13
88	Gauge for lub drums-small base	TRADOC	5	5	5	5	5	5
89	HVLP paint equipment-large base	TRADOC	13	13	13	13	13	13
90	HVLP paint equipment-small base	TRADOC	5	5	5	5	5	5
91	Lub dispensing system-big base	TRADOC	0	0	0	0	13	13
92	Lub dispensing system-small base	TRADOC	0	0	0	0	5	5
93	Non solv parts washer-big base	TRADOC	13	13	13	13	13	13
94	Non solv parts washer-small base	TRADOC	5	5	5	5	5	5
95	Oil analysis unit-big base	TRADOC	13	13	13	13	13	13
96	Oil analysis unit-small base	TRADOC	5	5	5	5	5	5
97	Oil filter crusher-big base	TRADOC	13	13	13	13	13	13
98	Oil filter crusher-small base	TRADOC	5	5	5	5	5	5
99	Oil filtration system-big base	TRADOC	0	13	13	13	13	13
100	Oil filtration system-small base	TRADOC	0	5	5	5	5	5
101	Paint booth	TRADOC	15	15	15	15	15	15
102	Paint gun washer-big base	TRADOC	13	13	13	13	13	13
103	Paint gun washer-small base	TRADOC	5	5	5	5	5	5
104	PCB ballast recycling	TRADOC	0	0	0	15	15	15
105	Recyc bins/containers-big base	TRADOC	0	0	0	13	13	13
106	Recyc bins/containers-small base	TRADOC	0	0	0	5	5	5
107	Solvent distillation unit-big base	TRADOC	0	0	13	13	13	13
108	Solvent distillation unit-small base	TRADOC	0	0	5	5	5	5

Table E-1. Case Study 1--P2 Investment Strategy Comparison (Max CS/A)
(page 4 of 4 pages)

Ref	PPO name	MACOM	fy96	fy97	fy98	fy99	fy00	fy01
109	Spill pad wringer-big base	TRADOC	0	13	13	13	13	13
110	Spill pad wringer-small base	TRADOC	5	5	5	5	5	5
111	Stage II vapor recovery-big base	TRADOC	0	0	0	13	13	13
112	Stage II vapor recovery-small base	TRADOC	0	0	0	5	5	5
113	Used oil storage	TRADOC	0	0	0	0	15	15
114	Var ratio prop paint sys-big base	TRADOC	13	13	13	13	13	13
115	Var ratio prop paint sys-small base	TRADOC	5	5	5	5	5	5
116	VOC container	TRADOC	0	0	0	0	8	15
117	Automated chemical tracking sys	USACE	1	1	1	1	1	1
118	Freon replacement	USACE	0	0	0	0	1	1
119	Halon system replacement	USACE	0	0	0	0	1	1
120	Replace halon fire extingr sys	USAPAC	0	0	0	0	0	1
121	Replace halon sys with CO2 sys	USAPAC	0	0	0	0	0	2
122	Solvent substitution	USAPAC	3	3	3	3	3	3
123	Update AC & refrig equip	USAPAC	0	0	0	0	0	1
124	Above ground fuel tank cover	USAR	0	0	1	1	1	1
125	Above ground storage tanks	USAR	0	0	0	0	0	2
126	CFC/Halon phase-out	USAR	0	0	0	0	6	6
127	CFC/Halon phase-out	USAR	0	0	0	0	6	6
128	CFC/Halon phase-out	USAR	0	0	0	0	11	11
129	Containment pallets	USAR	0	0	0	6	6	6
130	Cross connection preventors	USAR	0	0	0	0	1	1
131	Fluid backflow preventors	USAR	0	0	0	0	6	6
132	HW spill response equip	USAR	0	0	0	6	6	6
133	HW storage lockers	USAR	0	0	0	0	3	3
134	Used solvent recovery	USAR	6	6	6	6	6	6
135	Waste water recycling equipment1	USAR	0	0	0	6	6	6
136	Waste water recycling equipment2	USAR	0	0	0	6	6	6
137	Halon system replacement1	USMA	0	0	0	0	1	1
138	Halon system replacement2	USMA	0	0	0	0	0	6
139	Halon system replacement3	USMA	0	0	0	0	11	11
140	Halon system replacement4	USMA	0	0	0	0	5	5
141	Halon system replacement5	USMA	0	0	0	0	5	5
142	Recycleables baler	USMA	0	0	0	1	1	1
143	Solvent degreaser replacement	USMA	12	12	12	12	12	12

Table E-2. Case Study 1--P2 Investment Strategy Comparison (Min CS/A)
(page 1 of 4 pages)

Ref	PPO name	MACOM	fy96	fy97	fy98	fy99	fy00	fy01
1	Absorbent pad squeezer	8thArmy	0	0	0	20	20	20
2	Activated carbon fuel filter/drum	8thArmy	0	0	25	25	25	25
3	Aerosol can puncher	8thArmy	0	0	0	20	20	20
4	Anti-freeze recycler	8thArmy	0	6	6	6	6	6
5	Bead blast cleaner	8thArmy	0	0	0	0	13	13
6	Dustless sanders	8thArmy	0	0	20	20	20	20
7	Engine oil by-pass filter system	8thArmy	0	0	52	52	52	52
8	Fiberglass & metal bonding unit	8thArmy	0	0	4	4	4	4
9	Freon recycler	8thArmy	0	0	0	0	23	23
10	Hazardous waste compactor	8thArmy	0	0	7	7	7	7
11	High pressure water stripper	8thArmy	0	0	0	10	10	10
12	Paint gun cleaning machine	8thArmy	0	1	33	33	33	33
13	Spill cleanup equipment	8thArmy	0	0	36	36	36	36
14	Spill control equipment	8thArmy	0	0	1	1	1	1
15	Caustic cleaning blgd upgradei	AMC	0	1	1	1	1	1
16	CFC/Halon reduction project	AMC	1	1	1	1	1	1
17	Close loop waste wtr fr electplt shp	AMC	1	1	1	1	1	1
18	CO2 depainting system	AMC	0	1	1	1	1	1
19	Complete chrme recovery blgd 212	AMC	0	1	1	1	1	1
20	Consrt walled tst fire pit with sump	AMC	1	1	1	1	1	1
21	Conv of expl cmpd D to picric acid	AMC	0	1	1	1	1	1
22	Cooling water recycle waste min	AMC	0	1	1	1	1	1
23	Environmental chamber retrofit	AMC	1	1	1	1	1	1
24	HAZMIN closed loop cooling	AMC	0	0	0	1	1	1
25	HAZMIN CTX spray rinse-pltg tnks	AMC	0	1	1	1	1	1
26	HAZMIN envr optm metal finishing	AMC	0	1	1	1	1	1
27	HAZMIN:atomtd paint strp acft sys	AMC	0	1	1	1	1	1
28	HAZMIN:CTX chiller-pltg tnks	AMC	0	0	1	1	1	1
29	HAZMIN:CTX elctrdyls pltg tnks	AMC	0	0	0	1	1	1
30	HAZMIN:CTX electrowin-pltg tnks	AMC	0	0	8	8	8	8
31	HAZMIN:CTX hi pr wtr eqp-pet solv	AMC	0	0	0	3	3	3
32	HAZMIN:CTX proc purfctn conv coat	AMC	0	0	0	0	3	3
33	HAZMIN:CTX spray rinse pltg tnks	AMC	0	0	0	0	50	50
34	HAZMIN:CTX spray rinse pltg tnks	AMC	0	0	0	0	35	35
35	HAZMIN:Paint solvent rcvry sys	AMC	0	1	1	1	1	1
36	HAZMIN:permanganate clnr regen	AMC	0	1	1	1	1	1

Table E-2. Case Study 1--P2 Investment Strategy Comparison (Min CS/A)
(page 2 of 4 pages)

Ref	PPO name	MACOM	fy96	fy97	fy98	fy99	fy00	fy01
37	HAZMIN:pltg rinse for ion exch col	AMC	0	1	1	1	1	1
38	HM storage units	AMC	1	1	1	1	1	1
39	Install solvent recovery unit	AMC	0	1	1	1	1	1
40	Install water saving devices	AMC	1	1	1	1	1	1
41	Ion vapor deposition of aluminum	AMC	0	0	0	0	1	1
42	New abrasive blstg eqp (sm arms)	AMC	0	1	1	1	1	1
43	Oil/water separator for blgd 200-D	AMC	0	1	1	1	1	1
44	OWS for track hardstand	AMC	0	1	1	1	1	1
45	Plant trees for NDPES outfalls	AMC	0	1	1	1	1	1
46	Purchase and install barrel crusher	AMC	0	1	1	1	1	1
47	Recycle wash booth wash water	AMC	0	1	1	1	1	1
48	Reinsulate heat exchngrs-blgd 212	AMC	0	1	1	1	1	1
49	Replace vapor degreaser	AMC	0	1	1	1	1	1
50	Smoke mix extraction project	AMC	0	0	1	1	1	1
51	Steam condensate return system	AMC	0	1	1	1	1	1
52	Varsol reclaimation unit	AMC	0	1	1	1	1	1
53	Antifreeze recycler	ARNG	0	0	0	324	324	324
54	Jet pressure washer	ARNG	0	0	0	107	324	324
55	Non solvent parts washer	ARNG	0	0	0	0	176	324
56	Antifreeze recyc machs for site	FORSC	0	0	19	19	19	19
57	HVLP spray guns for paint shop	FORSC	0	0	0	0	19	19
58	Solargizers for site	FORSC	0	0	8	19	19	19
59	Replace inefficient HVAC equip	MDW	1	1	1	1	1	1
60	Retrofit/replace lighting fixtures	MDW	0	1	1	1	1	1
61	AC freon recvry unit-big base	TRADOC	13	13	13	13	13	13
62	AC freon recvry unit-small base	TRADOC	5	5	5	5	5	5
63	Alum can compactor-big base	TRADOC	0	13	13	13	13	13
64	Alum can compactor-small base	TRADOC	0	5	5	5	5	5
65	Antifreeze recycler-big base	TRADOC	0	0	0	13	13	13
66	Antifreeze recycler-small base	TRADOC	0	0	0	5	5	5
67	Bead blaster-big base	TRADOC	0	0	0	0	0	13
68	Bead blaster-small base	TRADOC	0	0	0	0	0	5
69	Cardboard baler-big base	TRADOC	0	13	13	13	13	13
70	Cardboard baler-small base	TRADOC	0	5	5	5	5	5
71	Drum cleaning unit-big base	TRADOC	0	0	0	0	0	13
72	Drum cleaning unit-small base	TRADOC	0	0	0	0	0	5

Table E-2. Case Study 1--P2 Investment Strategy Comparison (Min CS/A)
(page 3 of 4 pages)

Ref	PPO name	MACOM	fy96	fy97	fy98	fy99	fy00	fy01
73	Drum crusher-big base	TRADOC	13	13	13	13	13	13
74	Drum crusher-small base	TRADOC	5	5	5	5	5	5
75	Electrolytic silver recvry-big base	TRADOC	0	0	0	13	13	13
76	Electrolytic silver recvry-small base	TRADOC	0	0	0	5	5	5
77	Electrostatic paint sys-big base	TRADOC	0	0	0	0	13	13
78	Electrostatic paint sys-small base	TRADOC	0	0	0	0	5	5
79	Explosive proof fuel vac-big base	TRADOC	0	0	0	0	13	13
80	Explosive proof fuel vac-small base	TRADOC	0	0	0	0	5	5
81	Flor lamp disposal unit-big base	TRADOC	0	0	13	13	13	13
82	Flor lamp disposal unit-small base	TRADOC	0	0	5	5	5	5
83	Fluid evacuator-big base	TRADOC	0	0	0	0	13	13
84	Fluid evacuator-small base	TRADOC	0	0	0	0	5	5
85	Fuel bowser-big base	TRADOC	0	0	13	13	13	13
86	Fuel bowser-small base	TRADOC	0	0	5	5	5	5
87	Gauge for lub drums-big base	TRADOC	0	0	0	0	0	13
88	Gauge for lub drums-small base	TRADOC	0	0	0	0	0	5
89	HVLP paint equipment-large base	TRADOC	0	0	0	0	0	13
90	HVLP paint equipment-small base	TRADOC	0	0	0	0	0	5
91	Lub dispensing system-big base	TRADOC	0	13	13	13	13	13
92	Lub dispensing system-small base	TRADOC	0	5	5	5	5	5
93	Non solv parts washer-big base	TRADOC	0	0	0	0	0	13
94	Non solv parts washer-small base	TRADOC	0	0	0	0	5	5
95	Oil analysis unit-big base	TRADOC	0	0	0	0	13	13
96	Oil analysis unit-small base	TRADOC	0	0	0	0	5	5
97	Oil filter crusher-big base	TRADOC	0	0	0	0	13	13
98	Oil filter crusher-small base	TRADOC	0	0	0	0	5	5
99	Oil filtration system-big base	TRADOC	0	0	0	0	13	13
100	Oil filtration system-small base	TRADOC	0	0	0	0	5	5
101	Paint booth	TRADOC	0	0	0	0	0	15
102	Paint gun washer-big base	TRADOC	0	0	0	0	0	13
103	Paint gun washer-small base	TRADOC	0	0	0	0	0	5
104	PCB ballast recycling	TRADOC	0	15	15	15	15	15
105	Recyc bins/containers-big base	TRADOC	0	0	13	13	13	13
106	Recyc bins/containers-small base	TRADOC	0	0	5	5	5	5
107	Solvent distillation unit-big base	TRADOC	0	0	13	13	13	13
108	Solvent distillation unit-small base	TRADOC	0	0	5	5	5	5

Table E-2. Case Study 1--P2 Investment Strategy Comparison (Min CS/A)
(page 4 of 4 pages)

Ref	PPO name	MACOM	fy96	fy97	fy98	fy99	fy00	fy01
109	Spill pad wringer-big base	TRADOC	0	0	0	0	13	13
110	Spill pad wringer-small base	TRADOC	0	0	0	0	5	5
111	Stage II vapor recovery-big base	TRADOC	0	13	13	13	13	13
112	Stage II vapor recovery-small base	TRADOC	0	5	5	5	5	5
113	Used oil storage	TRADOC	15	15	15	15	15	15
114	Var ratio prop paint sys-big base	TRADOC	0	0	0	0	13	13
115	Var ratio prop paint sys-small base	TRADOC	0	0	0	0	5	5
116	VOC container	TRADOC	15	15	15	15	15	15
117	Automated chemical tracking sys	USACE	0	0	0	0	1	1
118	Freon replacement	USACE	1	1	1	1	1	1
119	Halon system replacement	USACE	1	1	1	1	1	1
120	Replace halon fire extingr sys	USAPAC	1	1	1	1	1	1
121	Replace halon sys with CO2 sys	USAPAC	1	2	2	2	2	2
122	Solvent substitution	USAPAC	0	0	0	0	3	3
123	Update AC & refrig equip	USAPAC	1	1	1	1	1	1
124	Above ground fuel tank cover	USAR	0	0	0	1	1	1
125	Above ground storage tanks	USAR	2	2	2	2	2	2
126	CFC/Halon phase-out	USAR	6	6	6	6	6	6
127	CFC/Halon phase-out	USAR	6	6	6	6	6	6
128	CFC/Halon phase-out	USAR	11	11	11	11	11	11
129	Containment pallets	USAR	0	6	6	6	6	6
130	Cross connection preventors	USAR	1	1	1	1	1	1
131	Fluid backflow preventors	USAR	6	6	6	6	6	6
132	HW spill response equip	USAR	0	0	6	6	6	6
133	HW storage lockers	USAR	3	3	3	3	3	3
134	Used solvent recovery	USAR	0	0	0	0	0	6
135	Waste water recycling equipment1	USAR	0	6	6	6	6	6
136	Waste water recycling equipment2	USAR	0	6	6	6	6	6
137	Halon system replacement1	USMA	1	1	1	1	1	1
138	Halon system replacement2	USMA	6	6	6	6	6	6
139	Halon system replacement3	USMA	11	11	11	11	11	11
140	Halon system replacement4	USMA	5	5	5	5	5	5
141	Halon system replacement5	USMA	5	5	5	5	5	5
142	Recycleables baler	USMA	0	1	1	1	1	1
143	Solvent degreaser replacement	USMA	0	0	0	0	0	12

Table E-3. Case Study 2--Integrated P2 Investment Strategy (PPO)
(page 1 of 4 pages)

Ref	PPO name	MACOM	fy96	fy97	fy98	fy99	fy00	fy01
1	Absorbent pad squeezer	8thArmy	20	20	20	20	20	20
2	Activated carbon fuel filter/drum	8thArmy	25	25	25	25	25	25
3	Aerosol can puncher	8thArmy	20	20	20	20	20	20
4	Anti-freeze recycler	8thArmy	0	0	6	6	6	6
5	Bead blast cleaner	8thArmy	13	13	13	13	13	13
6	Dustless sanders	8thArmy	20	20	20	20	20	20
7	Engine oil by-pass filter system	8thArmy	52	52	52	52	52	52
8	Fiberglass & metal bonding unit	8thArmy	4	4	4	4	4	4
9	Freon recycler	8thArmy	23	23	23	23	23	23
10	Hazardous waste compactor	8thArmy	7	7	7	7	7	7
11	High pressure water stripper	8thArmy	10	10	10	10	10	10
12	Paint gun cleaning machine	8thArmy	33	33	33	33	33	33
13	Spill cleanup equipment	8thArmy	36	36	36	36	36	36
14	Spill control equipment	8thArmy	1	1	1	1	1	1
15	Caustic cleaning blgd upgradei	AMC	0	0	0	0	0	1
16	CFC/Halon reduction project	AMC	0	0	0	0	0	1
17	Close loop waste wtr fr electplt shp	AMC	0	0	0	0	0	1
18	CO2 depainting system	AMC	0	1	1	1	1	1
19	Complete chrme recovery blgd 212	AMC	0	1	1	1	1	1
20	Consrt walled tst fire pit with sump	AMC	0	0	0	0	0	1
21	Conv of expl cmpd D to picric acid	AMC	0	0	0	0	0	1
22	Cooling water recycle waste min	AMC	0	1	1	1	1	1
23	Environmental chamber retrofit	AMC	0	0	0	0	0	1
24	HAZMIN closed loop cooling	AMC	1	1	1	1	1	1
25	HAZMIN CTX spray rinse-pltg tnks	AMC	0	1	1	1	1	1
26	HAZMIN envr optm metal finishing	AMC	0	1	1	1	1	1
27	HAZMIN:atomtd paint strp acft sys	AMC	0	1	1	1	1	1
28	HAZMIN:CTX chiller-pltg tnks	AMC	1	1	1	1	1	1
29	HAZMIN:CTX elctrdyls pltg tnks	AMC	1	1	1	1	1	1
30	HAZMIN:CTX electrowin-pltg tnks	AMC	8	8	8	8	8	8
31	HAZMIN:CTX hi pr wtr eqp-pet solv	AMC	3	3	3	3	3	3
32	HAZMIN:CTX proc purfctn conv coat	AMC	3	3	3	3	3	3
33	HAZMIN:CTX spray rinse pltg tnks	AMC	50	50	50	50	50	50
34	HAZMIN:CTX spray rinse pltg tnks	AMC	35	35	35	35	35	35
35	HAZMIN:Paint solvent rcvry sys	AMC	0	1	1	1	1	1
36	HAZMIN:permanganate clnr regen	AMC	0	1	1	1	1	1

Table E-3. Case Study 2--Integrated P2 Investment Strategy (PPO)
(page 2 of 4 pages)

Ref	PPO name	MACOM	fy96	fy97	fy98	fy99	fy00	fy01
37	HAZMIN:pltg rinse for ion exch col	AMC	0	1	1	1	1	1
38	HM storage units	AMC	0	0	0	0	0	1
39	Install solvent recovery unit	AMC	0	1	1	1	1	1
40	Install water saving devices	AMC	0	0	0	0	0	1
41	Ion vapor deposition of aluminum	AMC	1	1	1	1	1	1
42	New abrasive blstg eqp (sm arms)	AMC	0	1	1	1	1	1
43	Oil/water separator for blgd 200-D	AMC	0	0	0	0	0	1
44	OWS for track hardstand	AMC	0	0	0	0	0	1
45	Plant trees for NDPES outfalls	AMC	0	0	0	0	0	1
46	Purchase and install barrel crusher	AMC	0	1	1	1	1	1
47	Recycle wash booth wash water	AMC	0	1	1	1	1	1
48	Reinsulate heat exchngrs-blgd 212	AMC	0	1	1	1	1	1
49	Replace vapor degreaser	AMC	0	1	1	1	1	1
50	Smoke mix extraction project	AMC	1	1	1	1	1	1
51	Steam condensate return system	AMC	0	1	1	1	1	1
52	Varsol reclaimation unit	AMC	0	1	1	1	1	1
53	Antifreeze recycler	ARNG	324	324	324	324	324	324
54	Jet pressure washer	ARNG	324	324	324	324	324	324
55	Non solvent parts washer	ARNG	324	324	324	324	324	324
56	Antifreeze recyc machs for site	FORSC	19	19	19	19	19	19
57	HVLP spray guns for paint shop	FORSC	19	19	19	19	19	19
58	Solargizers for site	FORSC	19	19	19	19	19	19
59	Replace inefficient HVAC equip	MDW	0	0	0	0	0	1
60	Retrofit/replace lighting fixtures	MDW	0	1	1	1	1	1
61	AC freon recvry unit-big base	TRADOC	0	0	0	0	0	13
62	AC freon recvry unit-small base	TRADOC	0	0	0	0	0	5
63	Alum can compactor-big base	TRADOC	0	13	13	13	13	13
64	Alum can compactor-small base	TRADOC	0	5	5	5	5	5
65	Antifreeze recycler-big base	TRADOC	13	13	13	13	13	13
66	Antifreeze recycler-small base	TRADOC	5	5	5	5	5	5
67	Bead blaster-big base	TRADOC	13	13	13	13	13	13
68	Bead blaster-small base	TRADOC	5	5	5	5	5	5
69	Cardboard baler-big base	TRADOC	0	13	13	13	13	13
70	Cardboard baler-small base	TRADOC	0	5	5	5	5	5
71	Drum cleaning unit-big base	TRADOC	13	13	13	13	13	13
72	Drum cleaning unit-small base	TRADOC	5	5	5	5	5	5

Table E-3. Case Study 2--Integrated P2 Investment Strategy (PPO)
(page 3 of 4 pages)

Ref	PPO name	MACOM	fy96	fy97	fy98	fy99	fy00	fy01
73	Drum crusher-big base	TRADOC	0	0	0	0	0	13
74	Drum crusher-small base	TRADOC	0	0	0	0	0	5
75	Electrolytic silver recvry-big base	TRADOC	13	13	13	13	13	13
76	Electrolytic silver recvry-small base	TRADOC	5	5	5	5	5	5
77	Electrostatic paint sys-big base	TRADOC	13	13	13	13	13	13
78	Electrostatic paint sys-small base	TRADOC	5	5	5	5	5	5
79	Explosive proof fuel vac-big base	TRADOC	13	13	13	13	13	13
80	Explosive proof fuel vac-small base	TRADOC	5	5	5	5	5	5
81	Flor lamp disposal unit-big base	TRADOC	13	13	13	13	13	13
82	Flor lamp disposal unit-small base	TRADOC	5	5	5	5	5	5
83	Fluid evacuator-big base	TRADOC	13	13	13	13	13	13
84	Fluid evacuator-small base	TRADOC	5	5	5	5	5	5
85	Fuel bowser-big base	TRADOC	13	13	13	13	13	13
86	Fuel bowser-small base	TRADOC	5	5	5	5	5	5
87	Gauge for lub drums-big base	TRADOC	13	13	13	13	13	13
88	Gauge for lub drums-small base	TRADOC	5	5	5	5	5	5
89	HVLP paint equipment-large base	TRADOC	13	13	13	13	13	13
90	HVLP paint equipment-small base	TRADOC	5	5	5	5	5	5
91	Lub dispensing system-big base	TRADOC	0	0	0	13	13	13
92	Lub dispensing system-small base	TRADOC	0	0	0	5	5	5
93	Non solv parts washer-big base	TRADOC	13	13	13	13	13	13
94	Non solv parts washer-small base	TRADOC	5	5	5	5	5	5
95	Oil analysis unit-big base	TRADOC	13	13	13	13	13	13
96	Oil analysis unit-small base	TRADOC	5	5	5	5	5	5
97	Oil filter crusher-big base	TRADOC	13	13	13	13	13	13
98	Oil filter crusher-small base	TRADOC	5	5	5	5	5	5
99	Oil filtration system-big base	TRADOC	13	13	13	13	13	13
100	Oil filtration system-small base	TRADOC	5	5	5	5	5	5
101	Paint booth	TRADOC	15	15	15	15	15	15
102	Paint gun washer-big base	TRADOC	13	13	13	13	13	13
103	Paint gun washer-small base	TRADOC	5	5	5	5	5	5
104	PCB ballast recycling	TRADOC	0	15	15	15	15	15
105	Recyc bins/containers-big base	TRADOC	13	13	13	13	13	13
106	Recyc bins/containers-small base	TRADOC	5	5	5	5	5	5
107	Solvent distillation unit-big base	TRADOC	13	13	13	13	13	13
108	Solvent distillation unit-small base	TRADOC	5	5	5	5	5	5

Table E-3. Case Study 2-- Integrated P2 Investment Strategy (PPO)
(page 4 of 4 pages)

Ref	PPO name	MACOM	fy96	fy97	fy98	fy99	fy00	fy01
109	Spill pad wringer-big base	TRADOC	13	13	13	13	13	13
110	Spill pad wringer-small base	TRADOC	5	5	5	5	5	5
111	Stage II vapor recovery-big base	TRADOC	0	13	13	13	13	13
112	Stage II vapor recovery-small base	TRADOC	0	5	5	5	5	5
113	Used oil storage	TRADOC	0	0	0	0	0	15
114	Var ratio prop paint sys-big base	TRADOC	13	13	13	13	13	13
115	Var ratio prop paint sys-small base	TRADOC	5	5	5	5	5	5
116	VOC container	TRADOC	0	0	0	0	0	15
117	Automated chemical tracking sys	USACE	1	1	1	1	1	1
118	Freon replacement	USACE	0	0	0	0	0	1
119	Halon system replacement	USACE	0	0	0	0	0	1
120	Replace halon fire extingr sys	USAPAC	0	0	0	0	0	1
121	Replace halon sys with CO2 sys	USAPAC	0	0	0	0	0	2
122	Solvent substitution	USAPAC	3	3	3	3	3	3
123	Update AC & refrig equip	USAPAC	0	0	0	0	0	1
124	Above ground fuel tank cover	USAR	1	1	1	1	1	1
125	Above ground storage tanks	USAR	0	0	0	0	0	2
126	CFC/Halon phase-out	USAR	0	0	0	0	0	6
127	CFC/Halon phase-out	USAR	0	0	0	0	0	6
128	CFC/Halon phase-out	USAR	0	0	0	0	0	11
129	Containment pallets	USAR	0	6	6	6	6	6
130	Cross connection preventors	USAR	0	0	0	0	0	1
131	Fluid backflow preventors	USAR	0	0	0	0	0	6
132	HW spill response equip	USAR	6	6	6	6	6	6
133	HW storage lockers	USAR	0	0	0	0	0	3
134	Used solvent recovery	USAR	6	6	6	6	6	6
135	Waste water recycling equipment1	USAR	0	6	6	6	6	6
136	Waste water recycling equipment2	USAR	0	6	6	6	6	6
137	Halon system replacement1	USMA	0	0	0	0	0	1
138	Halon system replacement2	USMA	0	0	0	0	0	6
139	Halon system replacement3	USMA	0	0	0	0	0	11
140	Halon system replacement4	USMA	0	0	0	0	0	5
141	Halon system replacement5	USMA	0	0	0	0	0	5
142	Recycleables baler	USMA	0	1	1	1	1	1
143	Solvent degreaser replacement	USMA	12	12	12	12	12	12

Table E-4. Case Study 2--Integrated P2 Investment Strategy (ECO)
(page 1 of 2 pages)

Ref	ECO name	fy96	fy97	fy98	fy99	fy00	fy01
1	High Eff Motors (Large)	1,880	2,602	2,890	2,898	2,900	2,900
2	High Eff Motors (Medium)	1,979	2,954	3,068	3,292	3,294	3,294
3	High Eff Motors (Small)	14,880	25,655	31,124	31,595	34,661	34,661
4	VentIn Motor ASD (Large)	11	18	46	73	81	81
5	VentIn Motor ASD (Medium)	121	165	341	383	406	406
6	VentIn Motor ASD (Small)	14	1,075	1,871	2,043	2,230	2,230
7	6.5 Inch Addtnl Clg Insul	840,100	1,824,723	2,463,874	2,624,874	2,923,727	2,923,727
8	Ext Insul Finish Sys	0	0	0	0	0	0
9	FH 6.0 Inch Addtnl Clg Insul	0	0	1,158,890	1,768,969	5,471,059	5,471,059
10	FH Rockwool Wall Insulation	527,598	1,262,021	1,751,751	4,034,817	6,119,319	6,119,319
11	High Reflctnce Roof Membrn	0	0	0	0	0	0
12	Radiant Barriers	0	5,235,000	6,450,300	6,771,000	11,340,000	11,340,000
13	Shading Devices	0	0	0	0	0	0
14	Storm Windows	0	0	0	0	0	0
15	Window Film	725,510	1,570,475	2,216,052	2,478,398	2,809,381	2,809,381
16	Enthalpy Recvry Desscnt Wheel	1,003	1,003	1,003	1,003	1,003	1,003
17	Evap. Pre-Cool Air	0	0	0	0	0	0
18	FH Desuperheaters	5,571	19,193	23,581	26,299	36,180	36,180
19	FH Duct Seals	34,672	37,330	37,330	37,350	37,427	37,427
20	FH Flame Ret. Burners	1,512	1,512	1,512	1,512	1,512	1,512
21	FH Gas Engine Drvn HP	0	169	169	169	1,646	1,646
22	FH Ground Source HP	0	4,502	9,944	14,449	15,816	15,816
23	FH Heat Pumps	0	0	1,775	5,475	12,296	12,296
24	FH HiEff Gas Furn	0	426	426	426	753	753
25	FH HiEff Oil Furn	1,218	1,495	4,973	5,340	6,478	6,478
26	FH High SEER AC	5,254	5,254	6,075	7,270	7,270	7,270
27	FH Insulate Ducts	144,761	466,159	817,882	2,090,190	3,177,269	3,177,269
28	FH Nom Eff Gas Furn	0	0	53	1,873	4,709	4,709
29	FH Progrmmbl Thermostats	41,181	49,274	49,384	52,483	52,504	52,504
30	FH Whole House Fans w/AC	1,974	3,235	3,890	3,890	5,765	5,765
31	Flame Retention Burners	1,563	1,563	1,563	1,563	1,563	1,563
32	Gas Hieff Boilers	498	826	1,280	1,632	3,375	3,375
33	Gas Nomeff Boiler	0	704	1,104	1,212	1,996	1,996
34	Oil Nomeff Boiler	149	803	1,248	2,059	2,158	2,158
35	SLDC Panels	812	3,712	5,660	6,468	7,460	7,633
36	Ventilation Heat Recovery	3,802	6,657	6,938	7,131	7,284	7,284
37	4' Fluorescent Ltng	27,001	305,571	723,238	1,163,550	1,621,688	1,760,273
38	Compact Fluorescent Ltng	721,645	721,645	721,645	721,645	721,645	721,645
39	Constant Level Lighting	0	0	0	0	1,232	1,232

Table E-4. Case Study 2--Integrated P2 Investment Strategy (ECO) (page 2 of 2 pages)

Ref	ECO name	fy96	fy97	fy98	fy99	fy00	fy01
40	Exit Lighting	106,753	114,618	121,289	121,289	121,289	125,689
41	High Pressure Sodium Lghts	482	2,912	7,033	8,821	11,174	11,174
42	High wattage incand replcmnt	13,933	67,409	92,166	115,215	146,428	146,428
43	Occupancy Sensor	24,165	41,919	79,137	124,147	158,604	158,604
44	Efficient Computers	0	0	0	0	0	0
45	High Eff Refrig Replcmnt	60	1,190	6,744	7,749	8,967	8,967
46	Barracks Solar Water Htg	0	0	0	0	0	0
47	FH Passive Solar Sunspace	0	0	0	0	0	0
48	FH Solar Water Htg	0	126	259	9,989	9,989	9,989
49	Microclimate Modifications	15,549	15,549	15,549	15,549	15,549	15,549
50	Photovoltaic Peaking Station	0	0	0	0	0	0
51	Solar Street Lighting	0	0	0	0	0	0
52	SolarWall for Maint Bldgs	66,327	376,420	665,004	738,519	806,805	806,805
53	Wind Energy	0	0	99	175	175	175
54	Amorphs Core Transfrmrs	0	52,771	116,465	292,163	635,427	635,427
55	DF NG Chllrs 5-50 Tons	0	4	4	4	4	4
56	DF NG Chllrs 50-100 Tons	0	3	19	59	59	59
57	DF NG Chllrs >100 Tons	0	0	0	11	11	11
58	EMCS	1,421	3,119	6,245	10,224	10,778	10,778
59	GasEng Chllrs 5-50 Tons	0	0	11	19	19	19
60	GasEng Chllrs 50-100 Tons	0	52	75	133	133	133
61	GasEng Chllrs >100 Tons	0	6	84	108	108	108
62	HiEff Chllrs 5-50 Tons	0	0	0	0	0	0
63	HiEff Chllrs 50-100 Tons	0	0	1	1	41	41
64	HiEff Chllrs >100 Tons	28	62	137	236	262	262
65	Manhl Sump-Pmp I/R Prgrm	600	600	600	600	600	600
66	Storage Cooling Systems	31,233	60,266	100,917	106,808	115,525	115,525
67	Undrgrnd Heat Dist Sys Rprs	160	160	160	160	160	160
68	FH Hot Water Heat Pump	0	0	7	236	2,049	2,049
69	FH Low Flow Toilets	5,014	6,030	8,031	8,048	9,802	40,940
70	FH Tankless Water Heaters	0	0	5,728	11,330	11,726	11,726
71	FH Ultra Low Flow Toilets	8,919	10,862	22,733	28,234	34,742	77,762
72	Faucet Aerators	90,949	90,949	90,949	90,949	90,949	90,949
73	Flush Valve Retrofits	52,889	52,889	52,889	52,889	52,889	52,889
74	Horizntl Axis Washng Mchns	0	0	3,766	3,766	6,232	9,677
75	Low-flow Shower Head	30,317	30,317	30,317	30,317	30,317	30,317
76	Water Consrvng Dishwshrs	0	0	0	3,921	6,276	6,686
77	Water Distibtn Leak Repair	3,682	4,559	5,162	5,269	5,409	5,863
78	Wtr Htr Insulation Blanket	51,810	51,858	51,858	51,858	51,858	51,858

Table E-5. Case Study 3--P2 Investment Results as Installation Readiness Measures

Ref	PPO	Depot	FY 94	FY 95	FY 96	FY 97	FY 98	FY 99
1	Vehicle hull blasting unit	ANAD		1				
2	Airframe paint stripping	CCAD					1	
3	Laser rotor paint stripping	CCAD						1
4	Paint solvent recovery system	CCAD	1					
5	Alum conv coating filtration system	CCAD	1					
6	Replace chlorinated solvent degreasers	CCAD	1					
7	Coolant recovery system upgrade	CCAD	1					
8	Electrodialiytic system	CCAD	1					
9	Upgrade industrial waste treatment plant	CCAD				1		
10	Deionize spray rinse systems	CCAD		1				
11	Waterjet metal spray removal system	CCAD			1			
12	Aqueous ultrasonic cleaning system	CCAD			1			
13	Robotic waterjet paint/rust removal system	CCAD						1
14	Intermed size plastic blasting media	CCAD	1					
15	High pressure aqueous wash system	LEAD				1		
16	Line trough system integration (K-5)	LSAAP			1			
17	Industrial sewer replacement	LSAAP				1		
18	Sump and trough canopy system (Area B)	LSAAP	1					
19	Sump and trough system install (G-7)	LSAAP				1		
20	Mechanical cleaning system	LSAAP	1					
21	Treater waste water equip installation	LSAAP		1				
22	High pressure aqueous wash systems	RRAD		1				
23	Electrodialysis plating system	TYAD	1					
24	Organic wash water cleaning system	TEAD	1					
25	Electrodialysis plating solution recycling	WVA			1			
26	IONsep electropolish solution recycling	WVA	1					

KEY TO DEPOT LISTINGS:

ANAD - Anniston Army Depot
CCAD - Corpus Christi Army Depot
LEAD - Letterkenny Army Depot
LSAAP - Lone Star Army Ammunition Plant
RRAD - Red River Army Depot
TEAD - Tooele Army Depot
TYAD - Tobyhanna Army Depot
WVA - Watervliet Arsenal

APPENDIX F

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GLOSSARY

1. ABBREVIATIONS, ACRONYMS, AND SHORT TERMS

ACSIM	Assistant Chief of Staff for Installation Management
CCAD	Corpus Christi Army Depot
CS/A	cost saving/avoidance
ECO	energy conservation opportunity
EO	executive order
EPR	environmental program requirements
FY	fiscal year
HQDA	Headquarters, Department of the Army
IS	investment strategy
ISR	installation status report
kg	kilogram(s)
MACOM	major Army command
ODEP	Office of the Director of Environmental Programs
PAPA	Pollution Abatement and Prevention Analysis
PPO	pollution prevention opportunity
P2	pollution prevention
PR	pollution reduction
SECDEF	Secretary of Defense
USACE	US Army Corps of Engineers

2. DEFINITIONS

discounting

Adjustment of nominal dollar amounts to convert the dollar benefits flows to economically comparable amounts at a common point in time, by considering the time value of money.

energy conservation opportunity

An energy source or technology which, when used, installed, or substituted for an existing method, will reduce the consumption of energy at the location of the ECO and/or at the (remote) location where the power associated with the existing ECO is generated.

investment strategy

An analytically based plan for acquisition of environmental projects which identifies the projects to be bought in each fiscal year and the installations for which they are bought.

pollution abatement

The use of materials, processes, or practices that reduce the degree or intensity of pollution or eliminate pollution entirely.

pollution prevention

The use of materials processes or practices that reduce or eliminate the creation of pollutants or wastes at the sources.

pollution prevention opportunity

A technology, process, material, or procedure which, when used, installed, or substituted for an existing method, will prevent, eliminate or reduce the generation of pollution.

toxic materials

Includes, but is not necessarily limited to, the toxic chemicals identified in Section 313 (c) of the Emergency Planning and Community Right-to-Know Act of 1986. Federal agencies may also include, as toxic pollutants, releases of other chemicals deemed hazardous wastes or hazardous air pollutants under other statutes.